

RADIOLOGY

A MONTHLY JOURNAL DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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RADIOLOGY

A MONTHLY PUBLICATION DEVOTED TO CLINICAL RADIOLOGY AND ALLIED SCIENCES

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No. 6

The Treatment of Carcinoma of the Lower Lip¹

J. A. del REGATO, M.D.², and J. M. SALA, M.D.³

A VARIETY of procedures may be effective in the treatment of carcinoma of the lower lip, but the chances of control and the esthetic and functional results vary depending on the circumstances of the case. The form of treatment to be preferred is thus determined by the size of the primary lesion, the presence or absence of concomitant metastases, the degree of differentiation of the tumor, and whether or not the patient has received previous unsuccessful treatment.

The following considerations and conclusions are based on the study of 531 consecutive cases of previously untreated carcinoma of the lower lip admitted to the Ellis Fischel Cancer Hospital (Columbia, Mo.) from 1940 to 1953. A second group of 103 consecutive recurrences after treatment elsewhere is reported separately.

HISTOLOGY

In all of the 531 patients the diagnosis of carcinoma was confirmed by biopsy. Many cases of extensive ulceration of the lower lip with the clinical appearance of cancer proved to be chronic inflammatory lesions associated with hyperkeratosis and are not reported here.

The overwhelming majority of the tumors were well differentiated: 59 were of the so-called verrucous type and 336

were Grade I carcinomas. There were 103 cases classified as Grade II, and only 4 as Grade III. In 29 additional cases the diagnosis of carcinoma was made, but for various reasons grading could not be attempted.

TREATMENT OF THE PRIMARY LESION

In a great number of small carcinomas of the lower lip, a simple V-excision constitutes simultaneous biopsy and treatment; the procedure is expeditious and adequate provided that no more than one-fourth of the entire extent of the lip needs to be removed to assure a safe margin. Beyond this, surgical removal often requires a cheiloplasty, and the functional and esthetic results may be less satisfactory than those of radiotherapy. Resection of the primary lesion may be chosen, in spite of lesser esthetic result, in order to expedite the surgical treatment of a metastasis. In advanced lesions with jaw involvement or with a large defect, the surgeon may best plan his cosmetic attempts if he is allowed to manage the case from the beginning. Also, in cases of recurrence after various methods of treatment, surgery is often to be proposed. In the majority of lesions of moderate or large size, however, in the absence of concomitant metastases, radiotherapy, as directed by the circumstances

¹ Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

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Fig. 1. Extensive verrucous carcinoma of the lower lip invading the skin. A. Before treatment. B. After roentgen therapy, which was given over a period of several weeks.

of the case, is a much safer method and one which permits the most remarkable esthetic results.

In a few of the cases reported here, surface radium was used for the treatment of the primary tumor. This approach is certainly effective, though painstaking, in small lesions. The procedure was discontinued sixteen years ago. We feel that roentgen therapy can well satisfy all of the indications of radiotherapy.

The variations in technic of roentgen therapy are simply related to the size of the primary tumor. Most of the cases reported here were treated with 110 kv and 0.25 mm. of copper filtration. In a few advanced cases 250 kv was used; we sought the better quality rather than the penetration of the higher-voltage radiations. Since surgical excision was preferred for the small lesions, in the majority of those treated by roentgen therapy a treatment period of less than ten days was not justified. Fractionation was extended to six weeks in some cases, depending on the size of the area to be treated. The total dose administered must vary with the length of the treatment: our doses were of the order of 3,000 r (measured in air at the surface of the lesion) for treatments of less than ten days, and of as much as 7,000 r for treatments of six weeks duration. Daily applications of divided doses are

preferred, but the recent tendency has been to maintain the same daily dose throughout the course, until the desired total is attained.

We feel rather strongly that the care of the mucous membrane and skin reactions following radiotherapy is the responsibility of the radiotherapist. Their neglect leads to lesser esthetic results and to complications. Care of these radiation effects is best achieved by daily antiseptic spray and oily dressings. In some instances of contamination, administration of antibiotics becomes necessary until the epidermic layer is entirely repaired.

THE TREATMENT OF METASTASES

The metastasizing ability of carcinomas of the lower lip is rather low; only 33 (6 per cent) of the 531 cases in this series presented metastases on admission. In an additional 39 patients metastases subsequently developed: in 7 of this latter group there was a concomitant recurrence. The development of metastases was roughly related to the size of the primary lesion but more so to the degree of undifferentiation of the tumor: only 1 of the 59 verrucous carcinomas metastasized, and 36 among 336 Grade I carcinomas. The relative proportion of metastases was greater among the fewer undifferentiated tumors: 28 metastases among 103 Grade II carci-

Fig. 2.

Fig. 3.

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Fig. 2. Ulcerated carcinoma of the vermilion border of the lower lip. A. Before treatment. B. After roentgen therapy.



Fig. 3. Extensive multicentric carcinomas of the vermilion border of the lower lip. A. Before treatment. B. After roentgen therapy.

nomas, and 2 in the 4 cases of Grade III.

The most frequent site of metastasis from carcinoma of the lower lip is the prevascular node of the anterior submaxillary region, but metastases also occur in the submental region and in the facial node group in the lower part of the cheek, lateral to the jaw. The treatment of choice is a neck dissection. We formerly adhered to the view that a so-called suprahyoid dissection was sufficient in most cases, but experience has taught us that this operation is frequently inadequate. Since the metastasizing tumors are often of the more malignant variety, a more radical neck

dissection is justified; today this does not imply any greater risk to the patient and has a better record of control. Since the lymphatics of the lower lip may cross the midline, the neck dissection should often be extended to include the contralateral submental and submaxillary lymph nodes.

Because of the low incidence of metastases, a *prophylactic*⁴ neck dissection is not indicated as a routine procedure, but in the presence of highly undifferentiated advanced primary lesions or in patients with

⁴ A prophylactic neck dissection is one which is done for early treatment of likely metastases in a subclinical stage.

TABLE I: CARCINOMA OF THE LOWER LIP WITHOUT PREVIOUS TREATMENT AND WITHOUT METASTASES ON ADMISSION: CHOICE OF TREATMENT AND RESULTS RELATED TO SIZE OF THE LESION. 1940-1953

Size	Form of Treatment and Number of Cases		Dead Without Cancer Within Three Years	Total Local Recurrences*	Subsequent Metastases†	Dead with Cancer	Well Three Years or More	Absolute Three-Year Survival
Under 2 cm.	Surgery	210	35	7	14 (2)	4	171	81%
	Curietherapy	34	4	..	3	1	29	85%
	Roentgen therapy	62	11	..	..	..	51	82%
2-12 cm.	Surgery	45	10	5 (2)	1	2	33	73%
	Curietherapy	13	2	1	2 (1)	2	9	70%
	Roentgen therapy	129	21	12	19 (4)	9	99	76%
	Palliation	5	..	..	..	5	..	..
TOTAL		498	83	25	39 (7)	23	392	78%

* Eighteen local recurrences without metastases. All subsequently controlled except 2 in parenthesis.

† Figures in parentheses indicate concomitant recurrences.

TABLE II: CARCINOMA OF THE LOWER LIP: FATE OF PATIENTS WITH METASTASES. 1940-1953

	Treatment and Number of Patients		Dead Within Three Years Without Cancer	Dead with Cancer	Well Three Years or More	Absolute Three-Year Survival
Metastases on admission	Subtotal dissection	17	4	6	7	41%
	Radical dissection	6	..	1	5	83%
	Palliative	5	..	5	..	..
	Abstention	5	..	5	..	..
	TOTAL	33	4	17	12	38%
Subsequent metastases*	Subtotal dissection	18 (2)	4	5	9 (2)	50%
	Radical dissection	13 (3)	1	3 (2)	9 (2)	61%
	Palliative	5 (2)	..	5 (2)	..	..
	Abstention	3	..	3	..	..
	TOTAL	39 (7)	5	16 (4)	18 (4)	46%
GRAND TOTAL		72	9	33	30	41%

* Figures in parentheses indicate concomitant recurrences.

a history of previous unsuccessful treatment, an *elective prophylactic* neck dissection may occasionally be justified. Without denying that radiotherapy in any of its different manifestations is sometimes capable of destroying a metastatic focus, we feel that it is not a rational approach and that it cannot compete with neck dissection in a series of cases.

RESULTS

We have chosen to make a three-year term report of survival because (a) the proportion of deaths from intercurrent disease within a short time following treatment is rather large in this group of elderly patients; (b) only 3 of the 17 local recurrences took place after thirty-six months, and it is a question whether these may not have been second adjacent primaries rather

than recurrences; (c) only 4 of the 39 cases of metastases which became apparent after treatment were discovered after thirty-six months.

Statistics of results are not, of course, a statement of certainty as to the permanence of control. A five-year survival rate is considerably more meaningful in that respect for carcinoma of the cervix than for carcinoma of the breast. As indicated above, our patients with carcinoma of the lower lip were for the most part elderly; hence there was a large proportion of deaths from intercurrent diseases within three years. Had the survival period been longer, there is no assurance that a recurrence or metastasis might not have taken place in some of these patients and, consequently, they cannot be eliminated from the statistical considerations. On the other hand,

TABLE III: CARCINOMA OF THE LOWER LIP; RECURRENCES FROM PREVIOUS TREATMENT ELSEWHERE: CHOICE OF TREATMENT AND RESULTS. 1940-1953

Treatment and Number of Patients		Average Size	Dead Within Three Years Without Cancer	Recurrences	Subsequent Metastases	Dead of Cancer	Well Three Years or More	Absolute Three-Year Survival
Without metastases on admission	Surgery	23 1.9 cm.	2	1	1	3	18	77%
	Curietherapy	6 1.9 cm.	1	..	..	..	5	..
	Roentgen therapy	45 3.0 cm.	7	4	2	2	35	77%
	Palliation	2 6.2 cm.	..	..	..	2	..	..
	Abstention	1 2.5 cm.	..	..	..	1	..	..
TOTAL		77	10	5	3	8	58	78%
With metastases on admission	Subtotal dissection	12	2	..	..	4	6	} 50%
	Radical dissection	4	..	..	..	2	2	
	Palliation	3	..	..	..	3	..	
	Abstention	7	..	..	..	7	..	..
	TOTAL	26	2	..	..	16	8	30%
GRAND TOTAL		103	12	..	..	24	66	65%

such a large proportion of deaths from intercurrent diseases vitiates the appreciation of results through the three-year survival rate. Very few patients actually died of, or with, cancer: the results are best appraised through evaluation of failure to control the primary lesion or the metastases.

In patients without metastases on admission, the chances of success in the treatment of the primary lesion proved to be closely related to its size. In 306 patients with primary lesions measuring less than 2 cm. in diameter, the results were highly satisfactory: there was a total of 7 recurrences and 17 subsequent metastases, with only 5 deaths with cancer (Table I). Provided that they are practiced with proper skill, all forms of treatment are rather successful in the treatment of small lesions; this justifies our preference for surgery, since it is both effective and expeditious.

In 192 patients with lesions extending from 2 to 12 cm. in diameter, there were 18 recurrences and 22 subsequent metastases with 18 patients dead with cancer. The majority of these extensive lesions received roentgen therapy: only a few of moderate dimensions were treated by surgery. The proportion of recurrences and metastases appeared related to the size and the lack of differentiation of the tumors, but the esthetic results were much better with roentgen therapy.

Further subdivision of the groups according to size proved fruitless in cancers under 2 cm. and impractical in the larger lesions.

PATIENTS WITH METASTASES

The curability of patients with metastases on admission was relatively high: of a total of 33 patients (counting 10 who received no treatment or palliative treatment only) 12 (38 per cent) were cured. More than half of the patients operated upon were cured, with a definite advantage for the group with radical neck dissection (Table II).

In the patients without ostensible metastases on admission, in whom metastases later developed, a similar result was obtained: in a total of 39 such cases (counting 8 cases without treatment, or palliative treatment only), the disease was controlled in 18 (46 per cent); more than half of the patients operated upon were cured, with a slight advantage for those who received radical dissection.

In the total of 72 patients who had metastases either on admission or later, the cancer was controlled by surgery in 30 (41 per cent).

RECURRENCES FROM TREATMENT ELSEWHERE

The patients who apply for treatment of recurrences must be considered separately.

Unless they are segregated, a false impression of the degree of malignancy, of the metastasizing ability, of the frequency of recurrences, of the proportion of metastases, of the treatment of choice, and of the final results may be acquired.

In a total of 103 patients admitted with recurrent carcinomas of the lower lip following treatment elsewhere, there were 26 (25 per cent) with metastases, a proportion four times as great as that observed in those who had received no previous treatment. The curability of this group of patients was also inferior to the other group (Table III).

SUMMARY

1. Carcinomas of the lower lip are frequently highly differentiated and curable,

with a relatively low proportion of metastases.

2. Primary lesions measuring less than 2 cm. are curable by all methods, provided these are adequately applied. Surgery is preferable because it is expeditious.

3. Roentgen therapy is the treatment of choice for lesions measuring 2 cm. or more, because it is more flexible and yields the best esthetic results.

4. The treatment of choice of cervical metastases is a radical neck dissection. Prophylactic neck dissection is not advocated as a routine procedure.

5. Patients presenting recurrences following adequate or inadequate treatment have a larger proportion of metastases and constitute a serious problem.

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SUMMARIO IN INTERLINGUA

Le Tractamento de Carcinoma del Labio Inferior

Isto es un studio del resultatos trienne in 531 consecutive casos de previamente non tractate carcinoma del labio inferior, vidite inter 1940 e 1953. Un altere serie de 103 recurrentias post tractamento alterubi es reportate separatamente.

Carcinomas del labio inferior es frequentemente altemente differentiate e curabile. Le proportion de metastases es basse. Lesiones primari de dimensiones de minus que 2 cm es curabile per omne methodos, providite que istos es applicate adequatemente. Tamen, le methodo chi-

rurgic es preferibile proque illo es le plus expeditive. Roentgenotherapie es le tractamento de election pro lesiones de dimensiones de 2 cm o plus proque illo es le plus flexibile e produce le resultatos le plus esthetic. Le tractamento de election in casos de metastase cervical es un dissection radical del cervice.

Recurrentias post tractamento adequate o inadequate habeva un plus grande proportion de metastases que le casos que non habeva recipite ulle previe attention therapeutic.

(For Discussion of this paper, see page 848)

Radical Preoperative Roentgen Therapy in Primarily Inoperable Advanced Cancers of the Head and Neck¹

FRANZ BUSCHKE, M.D., and MAURICE GALANTE, M.D.

THE MISCONCEPTION of the prohibitive risk of major surgery in heavily irradiated tissues is still prevalent in the minds of many surgeons and even of some radiologists. The most significant progress in radiation therapy during the last decade or two consists perhaps in our ability to introduce high cancerocidal doses with preservation of the vasculo-connective tissues by the judicious use of two modalities: longer protraction and radiation of shorter wave lengths.

Baclesse (1) has recently reviewed some 2,000 epitheliomas treated between 1919 and 1950 with medium-volt roentgen therapy protracted between two and twelve weeks. By using this modality alone, without the advantage of higher voltages, he could increase the differential between tumor vulnerability and that of normal structures sufficiently to bring some otherwise incurable advanced carcinomas within the realm of curative radiation therapy. He also emphasized that, because of the better protection of normal tissues, the scope of preoperative irradiation could be extended considerably.

On the basis of earlier observations of Baclesse and our own previously reported experiences with well tolerated major surgical procedures following heavy super-voltage irradiation at the Swedish Hospital in Seattle (2), we began last year at the University of California Hospitals to select a number of patients with advanced epitheliomas of the oral cavity and oral pharynx for a planned combination of radical surgery with radical preoperative irradiation. The lesions represented differentiated epitheliomas of pillar, palate, floor of the mouth, and gingiva, of a type that can be expected to infiltrate locally or to remain limited to the regional lymphatic

areas for a long time, but too extensive for complete removal by primary surgery and either too differentiated or too invasive into bone, muscle, or lymph nodes for control by radiation therapy alone. The aim of this combined procedure is to increase the surgical margins of uninvolved tissue by carrying the dose high enough for control of the peripheral portion of the tumor but without attempting to sterilize the more resistant central portion or those areas which, because of bone or deep muscle involvement, could not be controlled. With this emphasis on sterilization of the peripheral portion of the disease, the fields should be sufficiently large. We did not, of course, follow Baclesse's technic of gradually decreasing the field size, since we were not particularly concerned with the control of the central region.

Radiation therapy was given at one million volts (3.2 mm. Pb h.v.l.) through a single field. The dose varied between 6,000 and 8,000 r (skin) in thirty-two to fifty-nine days, for a minimal tumor dose (calculated at the most distant edge of demonstrable involvement) of 4,100 to 6,500 r. One patient in this group with a lesion too extensive to permit determination of the origin was treated by Dr. Robert S. Stone with the 70 Mev synchrotron with a homogeneous dose through the involved volume of 6,000 r in forty-three days. No attempt was made in these cases to include the nodes, palpable or not, unless they happened to be in the field used for irradiation of the primary tumor.

Surgery was done from one to five and one-half months after completion of irradiation. The time depended on the observed response of the tumor during and following therapy, but the interval should,

¹ From the Departments of Radiology and Surgery, University of California School of Medicine, San Francisco, Calif. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

TABLE 1: TEN CASES OF CARCINOMA OF HEAD AND NECK

Patient	Location	r/Skin	Minimum Tumor Dose (r)	Treatment (days)	Field Size (cm.)	Date of Surgery	Interval Between Radiation and Surgery (mo.)	Surgical Complications	Microscopic Tumor in Specimen	Type of Surgery*
1. McF	Gutter	6,100	5,000	39	8 1/2 X 8	5/1/57	1 1/2	None	0	
2. F	Pillar	7,550	4,500	53	9 X 7	9/18/57	2 1/2	None	0	L
3. B	Floor	7,000	5,700	47	7 X 7	5/9/58	2	None	0/37	C
4. H	Floor	7,900	6,500	55	8 X 10	5/17/58	1	Minimal small necrosis, skin; minimal edema.	1/43	C
5. G	Pillar	7,000	4,800	49	10 X 8	7/25/58	5 1/2	None (more fibrosis at operation).	1/17	C
6. V	?	Synch.	6,000	43	8 1/2 X 10	4/28/58	3	None (more fibrosis at operation). 3 X 4 cm. skin necrosis, grafted; mucosa healed well.	0/23	C
7. B	Pillar	7,000 12/57	4,900	59	9 X 8	.....	.....	.....	0	C
8. D	Pillar	7,000	4,100	32	9 X 9	.....	.....	.....	0/53	C
9. E	Palate	7,000	4,400	66	8 X 8	8/15/58 (Exploratory)	1	Deep positive biopsy. Surgery abandoned.	..	None. Local control 8 months. New cancer of arytenoid.
10. F	Tonsil	7,300	5,300	55	10 X 7	5/13/58	5	Positive lower nodes. Surgery abandoned. Recurrence in tongue.	..	None. Well seventeen months. Exploratory.

* C, Combined procedure, including radical neck dissection (Commando). L, Limited excision, including resection of mandible.

NOTE: As of November 1959 Patients 1, 2, 3, 5, 6, 7 and 8 remained without recurrent active disease; Patient 4 died of uncontrolled disease in July 1959; Patient 9 was still alive with active disease. In Patient 3 an independent papillary carcinoma of the bladder developed in April 1959. Patient 7 was treated for carcinoma of the arytenoid in September 1958 and is symptom-free to date.

if possible, not exceed two to three months because of the progressing vascular and fibrotic changes. A combined operative procedure (so-called "Commando operation") was employed, whereby the primary lesion was removed *en bloc* with the cervical nodes, so as to obtain a continuous specimen which included tongue, tonsillar pillars, floor of the mouth, hemimandible, and the contents of a homolateral radical neck dissection.

Between February 1957 and February 1958, 9 patients were accepted for the planned procedure (Table I). In 6 instances the treatment was completed as originally intended. In 2 patients (advanced carcinomas of tonsillar pillar, Cases 7 and 8), the tumor regression was sufficient to warrant anticipation of possible control by irradiation alone, and surgery was abandoned. To date these patients have remained well for eighteen and ten months, respectively. In 1 patient (Case 9) surgery was abandoned because, on re-examination under anesthesia, one month after irradiation, biopsy through an apparently superficial remaining ulceration in the palate showed deep infiltration which would have made operation futile.

One patient with carcinoma of the tonsil (Case 10) is added in whom originally no surgery was planned, since we consider true tonsillar carcinoma—in distinct contrast to cancer of the pillar—unsuitable for this type of operation because of the biological character of this less differentiated epithelioma with its more widespread lymphatic extension. The patient was explored five months after irradiation because of a small recurrence on the adjacent portion of tongue; there were no palpable nodes. Disease in a retroclavicular node was demonstrated on frozen section, and surgery was given up as futile. The patient died two months later of mediastinal disease.

Regarding the final results, no conclusion is possible at this time. We can state only that thorough examination of the surgical

specimens in 3 patients seemed to indicate that the surgical excision was far beyond histologically demonstrable disease and that, in the 3 others, active disease was not demonstrable in the primary site or in lymph nodes.

The main purpose of this premature discussion, however, is to emphasize again the possibility of radical surgery in previously irradiated tissues. In spite of the heavy preoperative irradiation, there were no surgical complications in this small group of patients beyond those associated with this type of surgery when done initially. No fistulas occurred. In the patient who was operated on five and one-half months after completion of radiation therapy, more fibrosis of the fascial planes was noticed than in patients operated on after two to three months, but healing progressed satisfactorily in this case also.

This presentation demonstrates again that surgery and radiation therapy are not competitive or mutually exclusive. The well planned utilization of both disciplines can be of great help in the management of properly selected cases. But the most important single prerequisite for this kind of radical management is complete mutual understanding and continuous close co-operation between surgeon and radiotherapist in planning prior to treatment and throughout its entire course, with repeated re-evaluation of the response of the disease and of the tolerance of normal tissues, and corresponding adjustment of the original plan during and following irradiation.

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(For Summary in Interlingua and Discussion, see following page)

SUMMARIO IN INTERLINGUA

Roentgenotherapia Preoperatori Radical in Primarimente Inoperabile
Canceres Avantiates de Capite e Cervice

Sex patientes con avantiates epiteliomas del cavitate oral e del pharynge oral esseva tractate per un planate combination de chirurgia radical con irradiation preoperatori radical.

Roentgenotherapia esseva administrate a un million volts (con un spissitate de medie valor de 3,2 mm de plumbo) via un sol campo. Le dose variava inter 6.000 e 8.000 r (al pelle) in inter trenta-duo e cinquanta-novem dies, pro effectuar un dose minimal al tumor de inter 4.100 e 6.500 r. Le operation chirurgic esseva effectuate inter un mense e cinque menses e medie post le completion del irradiation. In illo le lesion primari esseva excidite in bloco de maniera que un sol e continue specimen esseva obtenite le qual includeva

le lingua, le arco palatin, le fundo del bucca, le hemimandibula, e le contento de un radical dissection cervical homolateral. Un precise examine del specimens chirurgic pareva indicar in 3 patientes que le excision chirurgic excedeva per multo le area de histologicamente demonstrabile morbo. In le 3 alteres, morbo active non esseva demonstrabile in le sito primari o in le nodos lymphatic.

Le resultatos in iste gruppo de casos demonstra le possibilitate de chirurgia radical in previememente irradiate histos. In despecto del forte irradiation preoperatori, il occurreva nulle complicationes chirurgic in ultra de illos que es associate con le mesme typo de chirurgia interprendite como mesura initial.

DISCUSSION

(Papers by del Regato and Sala; Buschke and Galante)

James W. J. Carpender, M.D. (Chicago, Ill.): It is always a privilege to discuss papers by Dr. Regato and Dr. Buschke. The only problem is that I find so little to say, since I always agree with them.

The results Dr. Regato has presented compare favorably with similar reports and are excellent. Several years ago Gladstone and Kerr reported a similar series with 74.2 per cent five-year survivals in 519 patients. In many of their cases, however, the diagnosis was made only on a clinical basis.

I agree with Dr. Regato on the place of the radical dissection. It should not be a routine measure. One should watch the patient carefully and do the dissection when suspicious nodes are found.

Of course, the care of the patient is most important. I would like to raise one point. Since the lesion must always be contaminated by the oral bacteria, wouldn't the routine use of antibiotics be wise?

Dr. Buschke has given a most important paper. At our institution the head and neck surgeons have finally found that they can operate without too much trouble following properly administered fractionated radiotherapy.

We have had fewer such patients than Dr. Buschke, and our procedures were not planned in advance, but our time relationships were about the same. This is a useful approach and should be employed more often.

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Pyelography in Renal Disease with Hypertension

Correlation Between Pyelographic Findings and Differential Renal Function Studies¹

LUCY FRANK SQUIRE, M.D., and JORGEN U. SCHLEGEL, M.D.²

THERE IS NO evidence as yet that ordinary "essential" hypertension is curable by any means known to us. Nevertheless, out of a sea of investigative material and conflicting clinical reports in the past thirty years, there has gradually emerged incontrovertible evidence that certain cases of hypertension are related to renal disease, may be curable if recognized before the heightened pressure becomes fixed, and probably depend on relative renal ischemia of still viable parenchyma. It is now possible to select some cases of renal hypertension which are curable by removal or repair of the guilty kidney tissue.

Our object in writing this paper is to alert the radiologist to the limitations of the role he can play in helping the clinician select the salvageable patient. It was undertaken subsequent to studies in a series of hypertensive subjects showing that in many instances the excretory pyelogram appeared normal although function on one side was known to be depressed. The radiologist must realize that, in spite of the fact that excretion of the currently employed opaque materials appears equal and of good density on both sides, he may in fact be looking at two kidneys of very different functional capacity, one of which is doing as much as ten times the work of the other. In reporting such a pyelogram, he may unintentionally imply equal function, leading to abandonment of further investigative studies. Although it is probable that few of us actually rely on the intravenous pyelogram as an index to function, the authors believe that most radiologists and the practicing clinicians whom they serve are unaware of the wide functional difference which may exist between the two kidneys in spite of a normal pyelogram.

HISTORICAL EVIDENCE THAT THERE ARE SALVAGEABLE PATIENTS

Although Bright (21) in his original article in 1836 recognized the relationship between renal disease and high blood pressure, it was not until almost one hundred years later that Crabtree (22) recorded cases in which a diseased kidney had been removed with consequent relief of associated hypertension. Within two years Ask-Upmark (23) discussed a series of postmortem examinations of hypertensive patients in whom renal disease was found on only one side. Goldblatt's work showing that hypertension could be produced by clamping the renal artery stimulated great interest in the problem. Butler (24) in 1937 for the first time successfully treated hypertension by nephrectomy and recognized it as related to unilateral renal disease. The success of this operation led to an overenthusiastic hope that unilateral nephrectomy might remedy many cases of high blood pressure. In 1948 Homer Smith (3), in a necessarily pessimistic report, reviewed 262 cases of hypertension in which what had appeared to be unilateral renal disease had been treated by nephrectomy with only 19 per cent cure. In spite of this gloomy report it is now possible ten years later to re-assay the entire situation in view of the improved investigative methods at our disposal and a series of insistently courageous articles reporting amelioration of hypertension related to unilateral renal disease in the more carefully selected patient. It now seems clear that the statistics on this subject have been muddled by the large number of nephrectomies performed on patients who cannot have had unilateral disease, or who had been hypertensive for a period long enough

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to cause generalized arteriolar changes and a fixed elevation of blood pressure.

In 1956 Smith (4) somewhat amended his earlier opinion, recognizing the fact that the urologist has at his command a cure for hypertension in the removal or repair of a responsible kidney. He also concluded that, although morphologic changes (contraction, pyelonephritis, alteration in size of one kidney, etc.) often indicate a guilty kidney when only the conventional methods of study are employed, many ambiguous cases exist in which finer methods are required. For these cases he recommended that studies include unilateral measurement of filtration rate and renal plasma flow.

One acceptable hypothesis with regard to the etiology of this type of hypertension proposes that an ischemic, or partly ischemic, kidney elaborates a proteolytic enzyme (renin) which reacts or combines with a plasma globulin (hypertensinogen) to produce an active pressor substance (angiotonin or hypertensin), a polypeptide, which elevates the blood pressure. From our study of the proved cases of renal hypertension in the literature together with our own, and a review of the surgical findings in each, it seems probable that relative renal ischemia may be caused in a number of ways. Congenitally defective blood supply with aberrant arteries of different sorts, renal artery embolus, thrombosis and infarct, intimal proliferation causing narrowing of the vessel, atherosclerotic plaques, aneurysm of the renal artery not infrequently associated with ptosis of that kidney, and fibrosis about the renal pedicle resulting from renal trauma have all been described repeatedly in salvaged patients. Pyelonephritis is also clearly related to the condition and perhaps causes a secondary decrease in vascularity of viable renal parenchyma.

Careful selection of the salvageable patient can immeasurably aid our understanding of the means by which the ischemic kidney produces hypertension. Kidneys removed from patients in whom hypertension is ameliorated should be

studied exhaustively by the pathologist, with painstaking dissection of the arterial supply, radiography of the injected specimen, and careful microscopic study. Up to now, conscientious reporting of both successes and failures in this sphere seems to indicate that failure is related either to delay in surgical intervention, hypertension having become fixed at a period of from four to twelve years prior to the investigation of the renal picture, or to the existence of unrecognized bilateral disease.

DELINEATION OF THE SALVAGEABLE PATIENT

In 1952 Perera and Haelig (5) reported a series of 20 patients with unilateral renal disease cured of hypertension by nephrectomy, together with another group of 20 patients in whom elevated blood pressure readings had persisted after surgery. By reviewing the clinical features of those cases in which the procedure had been successful, they were able to pinpoint the characteristic history of those amenable to surgical cure. They found that in these the course of the disease was likely to have been rapid and dramatic, with sudden onset, and that the hypertension could usually be shown to be of short duration. The patients had in many instances a relatively recent record of being normotensive. Headaches, retinopathy, and a high diastolic pressure were common. Although generally these patients had no previous history of hypertension, several cases seemed to be superimposed on a pre-existing benign or "essential" hypertension. The findings included a relatively high incidence of recent trauma to the abdomen or flank, episodes of abdominal or flank pain, a known source of emboli, and a history of renal disease, particularly pyelonephritis. Fifteen of the patients were under forty-two (75 per cent), but no age group was immune.

Various investigators have shown that in such patients the usual function studies employing bladder urine are worthless. Inasmuch as it is common for the good kidney to compensate for the failing func-

tion of the other, phenolsulfonphthalein clearance determined with bladder urine and other tests of this character may be entirely within the normal range. Microscopic examination of bladder urine is often normal, nor are blood chemistry values usually altered in the salvageable patient. Smith has stressed the fact that total excretory function is suspect as a diagnostic procedure because contralateral hypertrophy may compensate for unilateral malfunction.

It goes without saying that tagging the guilty kidney is the crux of the problem. Obviously in any case in which there are morphologic changes on one side, conventional intravenous and retrograde pyelography will be of value in the clinical assay of the patient. Alteration in kidney size or an advanced degree of pyelonephritis will usually be apparent from the intravenous pyelogram. In those cases, however, with a compromised renal blood supply and no morphologic changes, abnormalities are not likely to be demonstrable by intravenous pyelography, and the radiologist must report that excretion of the medium is equal and adequate on both sides, and that the draining structures appear normal. Poutasse and Dustan (13) have emphasized that the intravenous pyelogram may show an entirely normal picture in patients with obstructive arterial lesions.

Since, in the presence of an entirely normal intravenous pyelogram, there is no other way of knowing that vascular abnormalities are present, the young patient with malignant hypertension must be considered inadequately investigated unless aortographic studies are performed. In various hands aortography has demonstrated in this type of patient the presence of arteriosclerotic plaques, stenotic narrowings of the renal arteries with post-stenotic dilatation or aneurysm, anomalous arterial supply to the diseased kidney showing a striking decrease in the normal arborization of vessels throughout the parenchyma, obstruction of a part of the renal vascular tree from thrombosis and embolus, and

blocking of the arterial supply by post-traumatic fibrosis about the renal pedicle.

Poutasse and Dustan (13) have reported their findings in 104 selected patients in whom aortography was helpful in delineating the salvageable patient. They indicate three points as a basis in selecting patients for that procedure. They believe, first, that any hypertensive patient, regardless of age or duration of disease, who shows unexplained disparity in size or function of the two kidneys by intravenous urography, should be studied by aortography. They stress the fact that disparities in kidney length of as little as 1 or 2 cm. or slight delay in the appearance of radiopaque medium on one side may indicate renal arterial occlusive disease. They state that as a general rule a kidney shown by intravenous urography to be nonfunctioning, although it appears anatomically normal on the retrograde pyelogram, can be considered to have some type of obstruction of its vascular supply. Secondly, they feel that aortography is indicated in young patients, including children, who have unexplained hypertension. A third group in which aortography is recommended consists of older persons with sudden development of accelerated or malignant hypertension. They suspect that in these patients the malignant hypertension has been superimposed on a chronic benign hypertension as a result of some secondary cause related to vascular supply to the kidneys.

Inasmuch as aortographic findings are sometimes equivocal and difficult to interpret, and since there are some patients in whom aortography is clearly contraindicated for clinical reasons, differential function studies with catheters in both ureters may be employed as an index to renal function on the two sides. This procedure often indicates the diseased kidney in the absence of abnormality demonstrable either by intravenous pyelography or on the aortogram. Clearance methods of value in this type of examination include measurement, on the two sides of inulin clearance (as an index to glomerular filtration

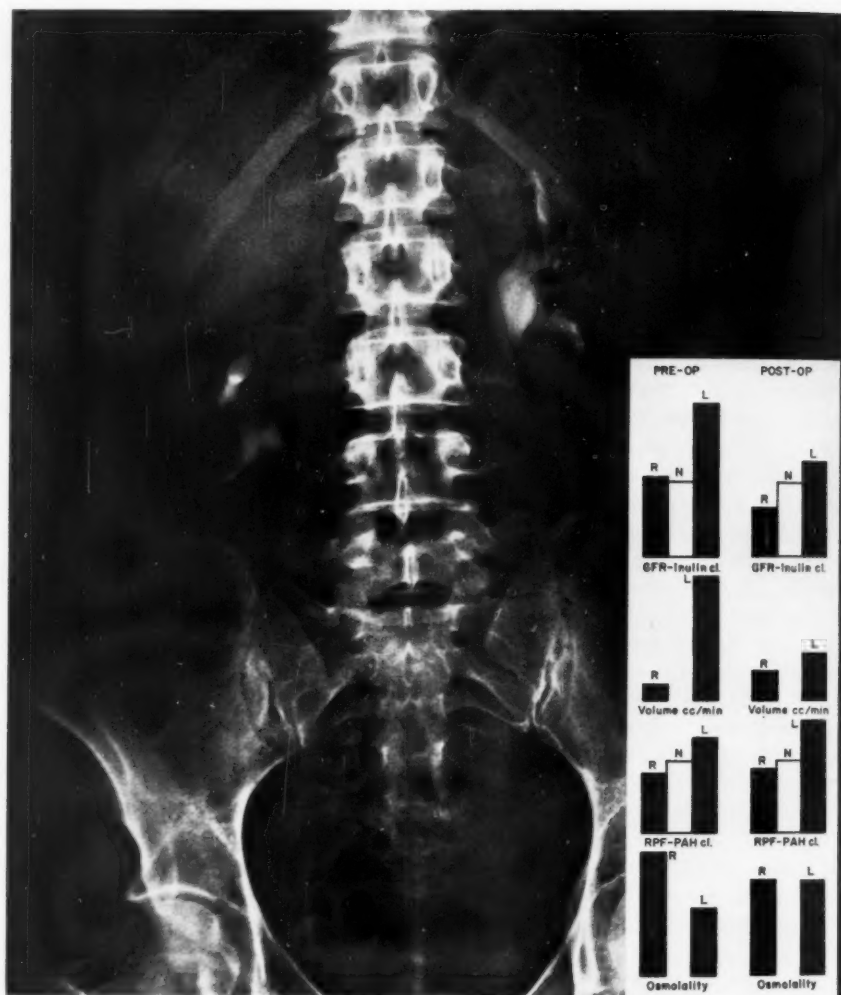


Fig. 1. Case I. Hypertension in a young woman with pronounced nephroptosis. Function tests demonstrated striking depression of function in spite of good pyelographic density of opaque medium on the ptotic side. The aortogram showed right renal aneurysm which was confirmed at surgery (nephropexy and reconstructive arterial shunt graft). Postoperative function tests showed improvement. See also Fig. 2.

rate), volume in cubic centimeters per minute, and Diodrast or para-aminohippuric acid (PAH) clearance (renal plasma flow). The validity of these procedures as an index to renal function is well recognized (1).

In this paper we shall include 6 cases (I-VI) of hypertension in young persons with unilateral renal disease proved at surgery in whom (a) aortography was only some-

times helpful, (b) intravenous urography was misleading because the results were almost uniformly normal, (c) differential renal function studies clearly showed the side on which renal disease existed. Correlation of renal function tests with the appearance of the pyelograms in 17 hypertensive patients has served to confirm our feeling that excretory pyelography may be very misleading.



Fig. 2. Case I (see Fig. 1). Aortogram. Arrow shows aneurysm of right renal artery.

METHOD

Intravenous urography was carried out on all our patients with 50 per cent Hypaque. The dose was determined by weight, but 30 c.c. was the usual dose for an adult. This was injected following suitable sensitivity tests, and films were made at five, ten, fifteen, and twenty minutes. Abdominal compression was applied following the five-minute film and removed just before the fifteen-minute film. The twenty-minute film was made with the patient standing if his condition warranted it, and with the table tilted if he was too ill to stand.

Differential kidney function tests were carried out with a No. 7 whistle- or olive-tipped catheter passed to each kidney. A No. 16 Foley catheter remained indwelling in the bladder during the procedure. By this means any leakage around the

catheters could be detected. In only a few of our cases did this occur, and none of them was included in this study.

One hour after injection of a priming dose of inulin and PAH followed by continuous infusion maintenance, two half-hour clearance tests were run. Because of varying degrees of discomfort and anti-diuresis, urea was given usually as an 8 per cent infusion in normal saline to promote osmotic diuresis. Hydration by mouth was continued.

Two clearance tests of half an hour duration were next done during the phase of osmotic diuresis. Following this, the patient was given an injection of chlorpromazine sufficient to lower the blood pressure (0.2 mg./kg. intravenously over a three- to four-minute period). Immediately afterward, two more half-hour clearance tests were run.

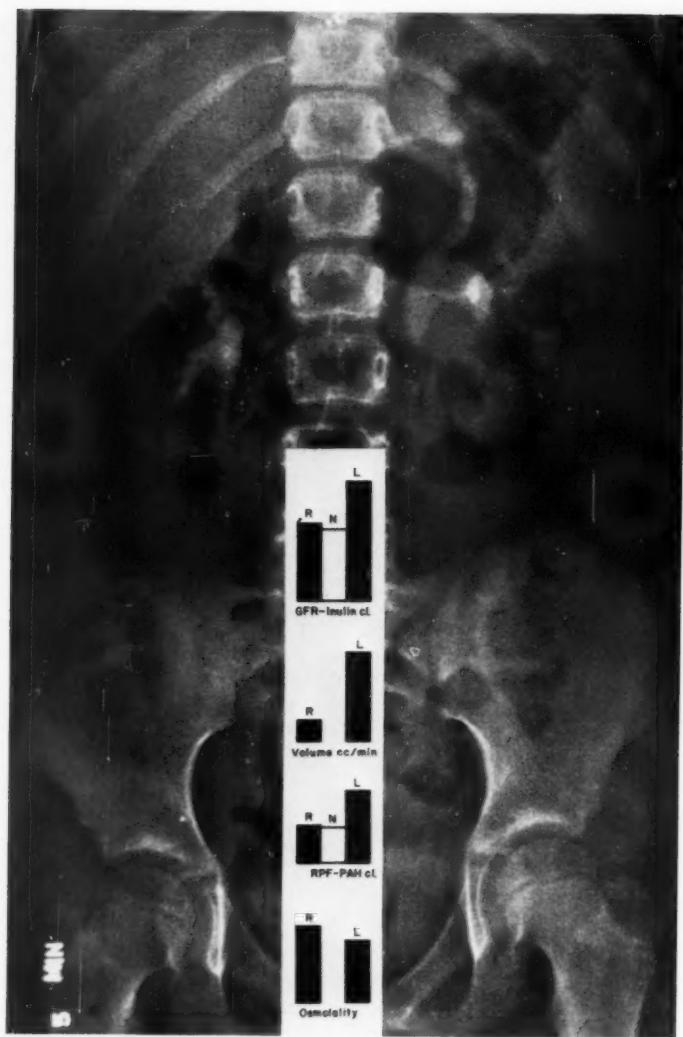


Fig. 3. Case II. Hypertension of sudden onset in a child. Pyelography showed normal density of opaque material, but differential function tests showed depression of function on the right side. The patient has been normotensive since nephrectomy, confirming diagnosis of anomalous and defective right renal circulation.

Inulin was determined by the resorcinol method with alkali treatment modified from Little and described in Homer Smith's *Principles of Renal Physiology* (26). PAH was determined by the method of Bragden and Marshall modified by Smith *et al.* (27). Urine osmolality and serum osmolality were determined on a Fiske osmometer, by the freezing point depression method.

Sodium and potassium determinations were performed on a flame photometer with lithium as an internal standard, and urea and ammonia were determined by the method of Van Slyke and Cullen.

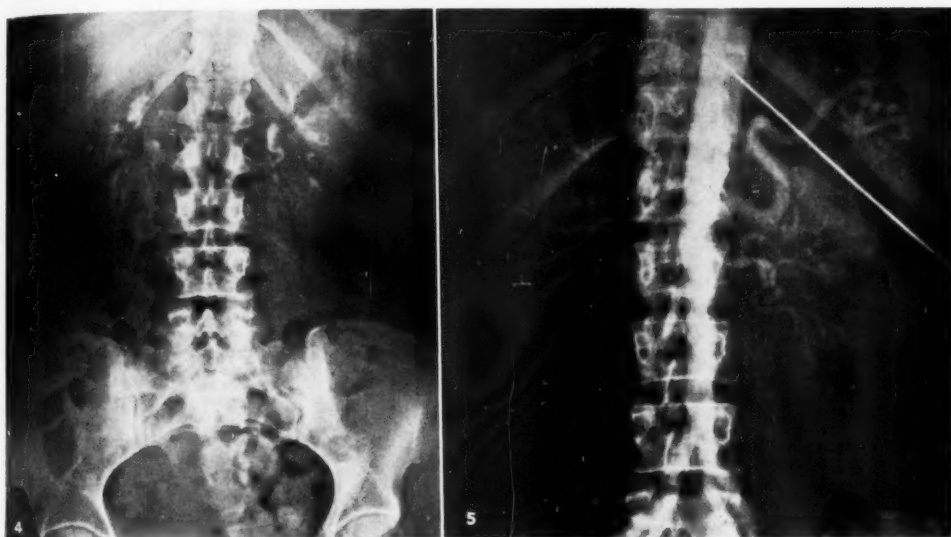
CASE REPORTS

CASE I: *Right nephroptosis and renal artery aneurysm.* R. K., a 34-year-old female, was known to have had hypertension for five years. Blood pres-

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Figs. 4 and 5. Case III. Hypertension of recent onset in a young woman. The pyelogram (Fig. 4) shows normal density (suggestion of pyelonephritis upper pole on right). The aortogram (Fig. 5) demonstrates anomalous circulation on right. Function tests consistently indicated depressed function on right. The patient has been normotensive since the performance of right nephrectomy, at which 4 small renal vessels plus focal chronic pyelonephritis were found.

sure was normal before that time. The admission blood pressure was 226/130. Physical examination was otherwise negative and no renal history was elicited. Intravenous pyelograms showed a ptotic right kidney but normal density of opaque medium on both sides. Antihypertensive therapy was prescribed and the patient was discharged. She was readmitted one year later with blood pressure ranging from 226/130 to 165/105. Differential renal function studies now showed striking depression on the right side. An aortogram revealed an aneurysm of the right renal artery. Surgical exploration was carried out and a nephropexy was performed. A shunt graft placed around the aneurysm resulted in improvement of pulsation in the arteries distal to it at surgery. Repeat function studies two months postoperatively still showed some depression on the right, but the patient was normotensive and has remained so for two years throughout a normal full-term pregnancy.

CASE II: Anomalous right renal arterial supply. B. M., an 8-year-old girl, was admitted with a blood pressure measurement of 184/120 discovered during an eye examination. She was known to have been normotensive two months before. The past history was entirely negative. Intravenous pyelography showed equal density on both sides and no morphologic abnormality. Retrograde pyelograms were also negative. Differential renal function studies revealed striking depression of function on the right side. Aortography showed the right kidney appar-

ently supplied by several very small arteries while the left arterial renal circulation appeared normal. Right nephrectomy was performed. No main renal arteries were found, the entire kidney being supplied from a small artery in the lower pole. The patient has remained normotensive for one year postoperatively.

CASE III: Pyelonephritis plus anomalous right renal arterial supply. E. B., a 31-year-old woman, gave a history of transient hypertension three years prior to admission. She was known to have had hypertension of 180/110 for seven months. Intravenous pyelography showed good density on both sides but there was some question of deformity of the upper pole on the right. Routine clinical studies were negative except for a bladder polyp and some edema, on cystoscopy. Differential renal function tests four months later showed depression of function on the right. Aortography demonstrated four small arteries supplying the right kidney and a normal left renal circulation. Right nephrectomy was performed and the anomalous character of the circulation was confirmed. Pathological examination showed, also, gross scarring and indentation with focal chronic pyelonephritis. Postoperatively the blood pressure has stabilized at 120/80 for one year at the time of this report.

CASE IV: Anomalous left renal arterial supply. C. T., a 36-year-old woman, gave a three-week history of severe headaches. She was known to have

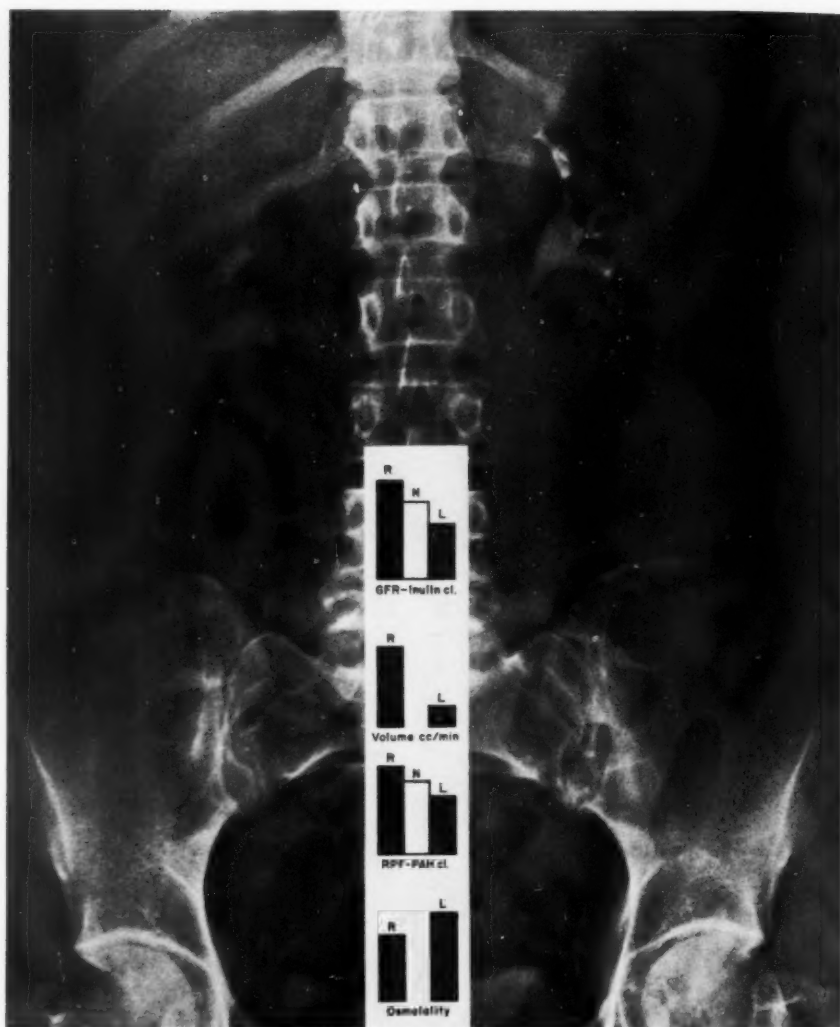


Fig. 6. Case IV. Normal pyelogram; no morphologic indications of disparity of function. The aortogram (Fig. 7) suggests generally decreased vascularity on the left and differential function tests consistently showed depressed function on that side. Surgery confirmed an anomalous blood supply and the patient has been normotensive since left nephrectomy. See also Fig. 7.

been normotensive three months before entering the hospital. Admission blood pressure was 170/110. There were bright red hemorrhages in the eye-grounds and some albumin in the urine, but no past genitourinary history. The intravenous pyelogram showed slightly decreased density on the right side but morphologically normal draining structures. The regitine test was negative. Differential kidney function tests revealed decreased function on the left and the patient was discharged on antihypertensive medication. She was readmitted two months later when decreased function on the left was again dem-

onstrated. Aortograms showed normal right kidney circulation but suggested some impairment of the lumen of one of the major branches of the left renal artery and some decreased arterial arborization within the kidney. Surgical exploration of the left kidney showed aberrant arteries of somewhat smaller caliber than normal to the upper and lower poles. Left nephrectomy was performed and the patient has remained normotensive postoperatively for two and one-half years. In this case the pyelogram suggested decreased function on the right, but function studies and aortography strongly impli-

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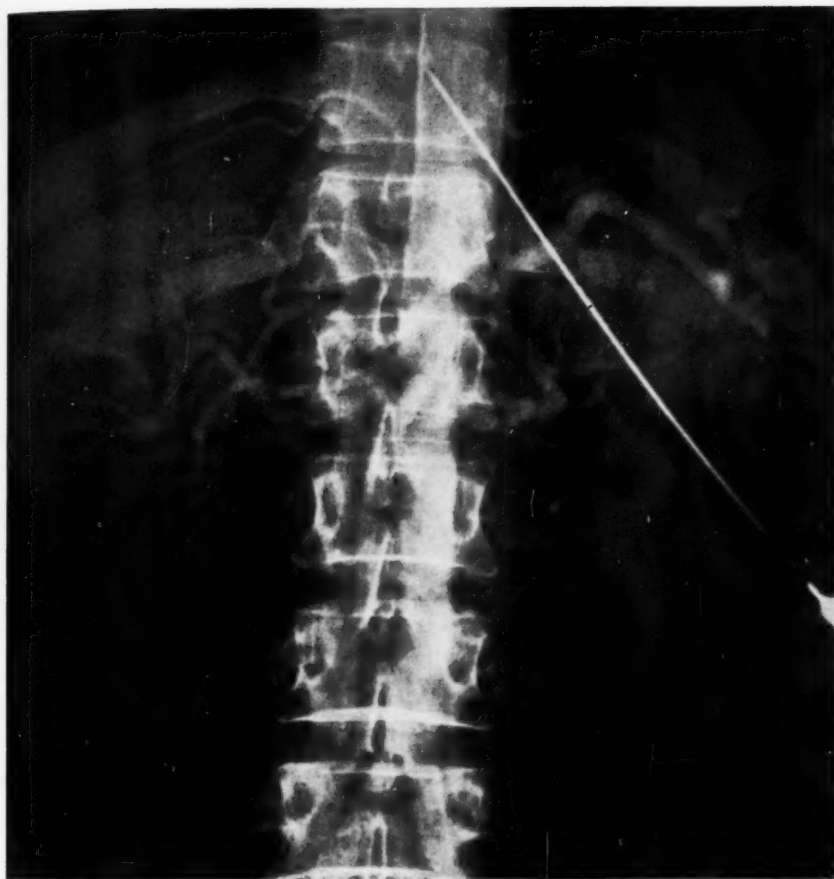


Fig. 7. Case IV (see Fig. 6). Aortogram.

cated the left kidney, removal of which restored the tension to normal levels.

CASE V: *Anomalous arterial supply, upper pole left kidney.* G. S., a 25-year-old male, was admitted with a history of hypertension known to have been present for three years. There was no history of genitourinary disease or renal trauma. Admission blood pressure was 180/110 and physical examination was otherwise negative. Differential kidney function tests showed slightly lowered function on the left side although the intravenous pyelogram was normal. The patient was readmitted six months later and a second series of kidney function tests still indicated depression of function on the left. Aortography showed the upper pole of the left kidney poorly vascularized, and surgical exploration was carried out. This revealed an aberrant artery supplying the upper pole of the left kidney while the rest of the organ was supplied by a normal-appearing main renal artery. The upper pole only was resected

and sections taken from it showed normal renal tissue while those from the body of the kidney revealed early arteriosclerosis. The patient became normotensive postoperatively and has remained so for one and one-half years. We believe the slightly ischemic upper pole acting as a "Goldblatt kidney" initiated the hypertension, but, because it was protected by its smaller artery in some way, arteriosclerosis did not develop.

CASE VI: *Trauma; scar tissue constricting renal artery.* B. H., a 22-year-old male, had suffered an injury to the left kidney in an automobile accident eleven years prior to admission. Ten years later pre-employment physical examination showed elevated blood pressure. An intravenous pyelogram revealed no abnormality except for slight distortion of the left renal pelvis. Aortography was equivocal, although it seemed to show some decrease in arterial supply to the left kidney. Differential function studies, on the other hand, clearly indicated de-



Fig. 8. Case V. Hypertension in a young man. Function tests showed consistent slight depression of function on left. The aortogram suggested aberrant arterial supply to left upper pole. Patient has been normotensive since resection of ischemic upper pole of left kidney.

pressed function on the left side. At surgical exploration dense fibrous adhesions were found about the left renal pedicle, with scar tissue replacing the central portion of the kidney and dividing it into two lobes. The blood supply was obviously diminished by encasement in scar tissue and a left nephrectomy was performed. The patient was normotensive postoperatively for a month and a half but has unfortunately been lost to follow-up.

CASE VII: Atherosclerotic plaque. M. S., a 39-year-old female, gave a fourteen-year history of hypertension dating from pregnancy with toxemia. She was admitted with a blood pressure of 224/150 and eyegrounds showing tortuous arterioles. Intravenous pyelography showed good density on both sides but the right kidney was somewhat smaller than the left. The differential renal function tests demonstrated definitely decreased function on the right.

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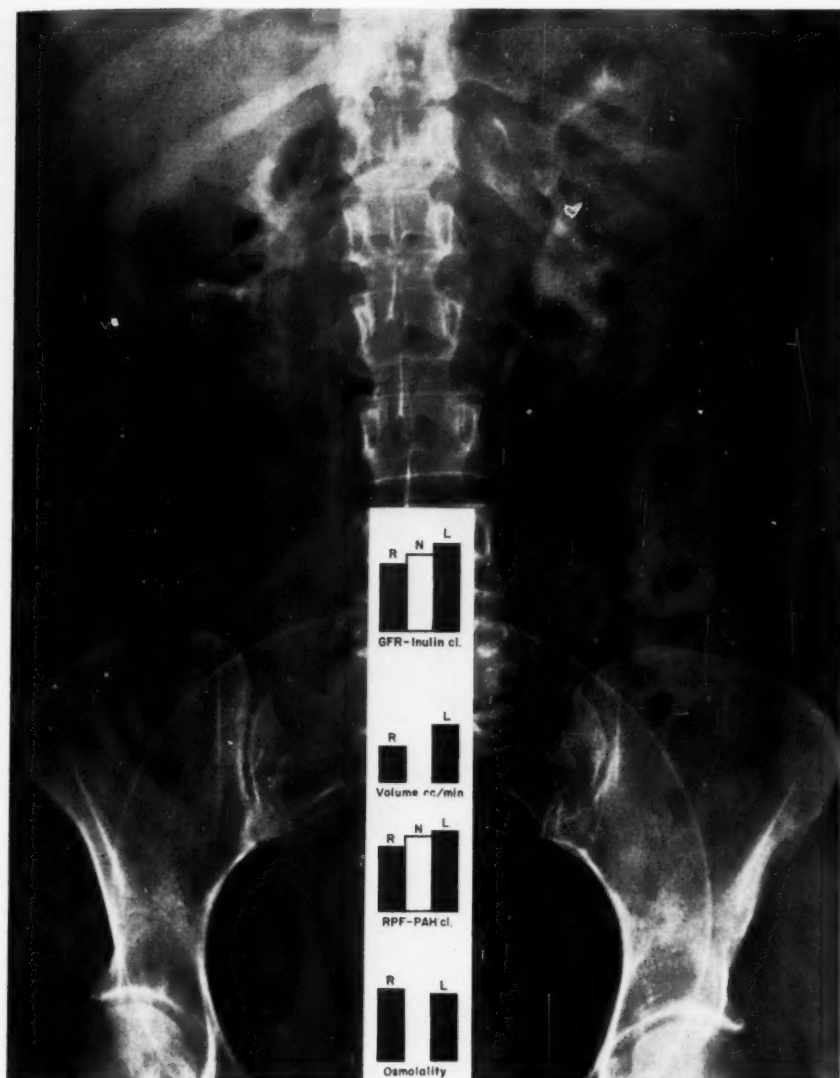


Fig. 9. Case VII. Normal pyelogram in spite of depression of function on the right. Surgery confirmed decreased right renal blood flow, showing large plaque in renal artery. In retrospect, nephrectomy was ill-advised in this patient, in view of a fourteen-year history of hypertension.

Aortography was not performed. At surgery the right kidney was small and the renal artery contained a large atherosclerotic plaque at its bifurcation. A right nephrectomy was performed and microscopic study showed advanced arteriosclerosis. The patient has remained hypertensive at 160/110 and has been placed on antihypertensive drugs. She probably had fixed hypertension at the time of operation, and it is questionable whether surgery should have been attempted.

CASE VIII: Contracted kidney probably the result of infarction. V. J., a 40-year-old woman, had rheumatic heart disease with mitral commissurotomy in 1953 and postoperatively a saddle embolus at the aortic bifurcation. She was known to have been normotensive before that time but in the year following operation her blood pressure was recorded as 150/110, and in the three years since operation it had risen to 230/110. She was admitted to the hospital with retinal hemorrhages. An intravenous

pyelogram revealed an abnormally small right kidney which, however, seemed to function and was of equal density to that on the left. Aortography was considered to be contraindicated. Differential kidney function tests showed markedly diminished function on the right, with some depression also present on the left. Since there was bilaterally depressed function, surgery was not thought feasible. It was felt that the hypertension probably resulted from embolization of the right kidney.

CASE IX: *Contracted right kidney, possibly from infarction.* L. D., a 49-year-old female, gave an eleven-year history of hypertension. An episode of sudden right-sided abdominal and flank pain had preceded the hypertensive period. Intravenous pyelography showed a small right kidney. On admission, the blood pressure was 200/150 and there was a 2+ papilledema with exudates and hemorrhages in both fundi. Retrograde pyelography showed a small contracted right kidney. Differential renal function tests revealed almost no function on the right but no compensatory hypertrophy or increased function on the left. Nevertheless, a right nephrectomy was performed and pathologic study of the right kidney showed parenchymal scarring and glomerular sclerosis. Postoperatively the blood pressure did not change and must be considered to have been already fixed at the time of surgery.

CASE X: *Function depressed bilaterally; normal pyelogram.* R. I., a 57-year-old man, had had known hypertension for seven years. He was admitted with nonprotein nitrogen of 45. Intravenous pyelography showed normal density of opaque medium and kidney structures on both sides. Aortography was not performed, but the differential renal function tests showed depressed function bilaterally, and the patient was accordingly not considered suitable for an operative approach.

CASE XI: *Function depressed bilaterally, more on the right; pyelogram normal.* H. N., a 48-year-old woman, was known to have been hypertensive for twelve years. She was admitted for study, and intravenous pyelography showed the right kidney to be slightly smaller than the left but with good density of opaque medium on both sides. Aortography was not performed because of a history of one episode of cardiac failure. Differential renal function tests showed depressed function on the right. There was also slight depression of function on the left. The patient was discharged on antihypertensive therapy, surgical remedy not being considered feasible in view of the ten-year history of documented hypertension plus bilateral depression of function.

CASE XII: *Depression of function apparently due to pyelonephritis; pyelogram showed good density.* A. G., a 51-year-old woman, gave a history of hypertension for eight to ten years. Intravenous pyelography showed marked blunting of the calyces of the right kidney, especially at the superior pole, with

a normal left kidney. There were persistent 2+ albuminuria and some pyuria. Blood pressure on admission was 210/120. Differential renal function tests showed decreased function bilaterally, more pronounced on the right. The patient was discharged on antihypertensive therapy, not being considered suitable for surgery in view of the lengthy history of hypertension plus bilateral impairment of function.

CASE XIII: *Pyelogram normal in spite of bilaterally depressed function.* D. P., a 35-year-old woman, was known to have been hypertensive for seven years. Admission blood pressure was 190/120 and there were morning headaches, with shortness of breath on exertion. The fundi showed slight arterial narrowing. Intravenous and retrograde pyelograms were normal, showing good excretion of dense opaque medium on both sides and no morphological abnormality. Differential renal function tests showed bilateral decrease of function, more pronounced on the right. Hypertension was not clearly related to unilateral kidney disease, therefore, and a bilateral dorsolumbar sympathectomy was done. The patient became normotensive after surgery, with marked amelioration of her symptoms to date.

CASE XIV: *Unilateral depression of function apparently due to obstructive nephropathy.* In J. D., a 22-year-old man, hypertension was discovered on routine physical examination. Admission blood pressure was 190/115, with the patient otherwise entirely normal. Intravenous pyelography revealed a striking decrease of density of the opaque medium on the right and a retrograde pyelogram showed marked dilatation of the calyces and pelvis on that side. The impression was that of an atrophic right kidney, possibly the result of obstructive nephropathy. Differential tests showed function on the left to be normal while that on the right was strikingly decreased. Surgery was recommended, as it was felt that this case was clearly delineated as hypertension related to unilateral renal disease in a young person. To date the patient has refused operation.

CASE XV: *Unilateral decreased function but normal pyelogram.* M. A., a 29-year-old male, was known to have had hypertension of 170/110 for six years. There had been recurrent bouts of urinary tract infection. The intravenous pyelogram was normal. Both a Diodrast renogram with I^{131} and differential renal function tests disclosed depression of function on the right. Aortography showed the right renal artery to be somewhat smaller than on the left. The patient is being considered for right renal surgery in spite of his six years of hypertension but to date has not been operated on because of an intercurrent infection.

CASE XVI: *Unilateral nephroptosis; normal pyelogram.* D. H., a 48-year-old woman, had hypertension of 180/110 with no past history of renal dis-

case. An intravenous pyelogram revealed a right nephroptosis of about 3 inches with the patient standing. The laboratory work-up was essentially negative. Differential renal function studies with the patient lying down showed normal findings on both sides, but, when the table was tilted so that ptosis was produced on the right, there was a pronounced difference, with a drop in function on the right to two-thirds that of the left. In view of these findings, it was considered probable that the circulation of the right kidney was compromised whenever the patient was standing and that hypertension may have been initiated by ischemia as a result of these changes. Nephropexy has been recommended.³

CASE XVII: *Normal pyelogram in spite of bilateral depression of function.* In J. K., a 41-year-old male, routine physical examinations over a five-year period showed gradual rise of blood pressure from 120/80 to 180/120, without other symptoms or signs. Intravenous pyelography showed morphologically normal kidney-draining structures and prompt appearance of opaque medium of good and equal density on the two sides. Nevertheless, function studies showed bilateral depression of function, sufficient to contraindicate surgery. Aortography was not performed.

SUMMARY OF CASES AND CORRELATION OF PYELOGRAPHIC FINDINGS WITH DIFFERENTIAL FUNCTION TESTS, AORTOGRAPHY, AND SURGICAL RESULTS

Our study was directed toward correlation of intravenous pyelograms with differential kidney function studies in 17 patients. All of the series were hypertensive and were being studied clinically in an attempt to determine whether the hypertension was renal-related, and whether they might therefore be salvaged by nephrectomy or reconstructive arterial surgery on a possibly ischemic kidney on one side. *In all of these patients except 1, excretion of the opaque medium was of good density on both sides in spite of striking unilateral or bilateral depression of function.* In 1 patient (Case XIV), density was strikingly decreased on the guilty side. This was the only patient in whom obstructive nephropathy seemed to be present. In 10 patients the pyelograms were thought to be entirely normal, although unilateral ptosis was present in 2. In 4 of the 17,

various degrees of contracted kidney on the abnormal side were demonstrated: in 2 there was a definite pyelonephritis and in 1 (Case VI) a distortion of the pelvis which proved to be the result of trauma with scarring. In summary, therefore, in 9 of these 17 patients the intravenous pyelographic findings were no index to the fact that unilateral kidney disease existed, while in 7 others there were morphologic changes of various sorts which helped to indicate the responsible kidney, although the density of opaque medium was usually about the same on both sides. In the last patient (Case XVII), pyelograms were entirely normal both as to density of contrast material and morphology of draining structures, in spite of bilateral depression of function.

Aortographic studies were carried out on 8 of the 17 patients. The remainder were not so studied, either because of clinical contraindication or because function tests already indicated bilateral disease. Of the 8 aortograms, 1 was equivocal and 7 were helpful in indicating the guilty kidney.

Differential function studies were of great value in delineating the salvageable patient. In some they demonstrated unilateral disease and the degree of compensation on the contralateral side. They were also of prime value in showing clearly which cases were unsuitable for surgery because of bilateral depression of function.

Six of the 17 patients (Cases I through VI) proved to have hypertension related to unilateral renal disease; in 5 of these nephrectomy was performed with relief of hypertension and they can be considered cured. The sixth is also cured, but after arterial surgery (shunt graft) for correction of an aneurysm, with nephropexy rather than nephrectomy. She has remained normotensive postoperatively. Nephrectomy was carried out in 2 more of the 17 patients, and in these 2 operation must be considered a failure, inasmuch as they remained hypertensive postoperatively. Both patients had a long history of hypertension (eleven and twelve years

³ Nephropexy has recently been performed on this patient.

respectively), which was probably fixed and should have contraindicated nephrectomy even in the presence of clear-cut unilateral renal disease. Six of the 17 patients were deemed not suitable for operative treatment because of bilateral depression of function, although 1 responded well after a bilateral lumbar sympathectomy. In the remaining 3 patients surgical exploration of what appears to be unilateral renal disease causing hypertension has been recommended. One of these patients has refused surgery, a second is considering it, and the third has not yet recovered from an intercurrent infection.

COMMENT

Approximately one-fifth of the plasma is filtered into the glomerular capsules, the glomerular filtrate being a simple ultrafiltrate containing the non-colloid constituents of the plasma. In the tubules almost all the water is reabsorbed, along with many of the other constituents of the filtrate such as glucose, chlorides, etc. Some substances are either not reabsorbed or are only slightly reabsorbed, and others are excreted by the tubules. Among the substances not reabsorbed are inulin and certain organic iodine compounds such as Diodrast and para-aminohippuric acid (PAH). Diodrast and PAH, beside being filtered, are partly excreted by tubular secretion, while inulin is excreted exclusively by glomerular filtration. Hence inulin is used for determination of filtration.

With low plasma levels the blood is almost completely cleared of PAH or Diodrast by one passage through the kidneys, wherefore clearances of these substances can be used for determination of effective renal blood flow. Since the chemical determination of PAH is simpler, it has been used widely as a substitute for Diodrast clearance studies. Recent writings seem to indicate that the excretion of Hypaque is similar to that of Diodrast and PAH, although it may not occur in precisely the same fashion (28, 31-33).

The volume of urine excreted by each

kidney in cubic centimeters per minute is also an important index to the work capacity of that kidney, a reflection of the volume of blood which reaches the kidney per unit time as well as of its water-reabsorbing powers.

Using all the above methods of estimating the functional capacity of the two kidneys separately, and correlating these differential function tests with the appearance of the excretory urogram, we have been struck by the fact that the contrast density of the opaque medium over the renal pelvis cannot be taken as an index to function. In Case IV the contrast density was greater over the kidney which had shown marked depression of function as compared with that over the opposite hypertrophied kidney. The implication of this type of finding, as we see it, is that the kidney with depressed function, and in most instances a compromised or very much reduced renal blood flow, secretes a smaller volume of somewhat more concentrated urine. The compensating kidney, on the other hand, seems to secrete a much larger volume of urine of a lower concentration with the result that its appearance on the pyelogram may be of low density. Correlation of the osmolality of the urine from the two kidneys in this type of case confirms these impressions.

SUMMARY

Hypertension due to unilateral renal disease is curable in carefully selected patients provided nephrectomy or reconstructive arterial surgery is undertaken soon enough. Failures are due to unrecognized bilateral disease or fixed hypertension of several years duration resulting in generalized arteriolar changes.

The intravenous pyelogram is not helpful in indicating a guilty kidney in the absence of morphologic changes. The pyelographic findings, blood chemistry, urine, and conventional function studies are often normal in patients with renal ischemia due to some type of arterial obstruction.

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Radiologists must recognize that in reporting a pyelogram as normal, they may inadvertently imply the presence of equal function on the two sides, and so reassure the referring physician that he abandons further function studies on the truly salvageable patient.

Some type of obstructive arterial disease is usually present in these cases. The following have been reported in proved cases in the literature with return of normal tension after operation: aberrant arteries, renal artery aneurysm, obstruction due to embolus, thrombosis, plaques, and intimal proliferation, renal infarct, constriction of arteries in scar tissue secondary to trauma, and pyelonephritis. Ischemia of still viable renal tissue probably initiates the hypertension.

Where no known contraindication exists, aortography should be performed in hypertensive cases in addition to differential kidney function tests with catheters in both ureters and simultaneous measurement of inulin clearance (glomerular filtration rate), volume in cubic centimeters per minute, and PAH (para-aminohippuric acid) clearance (renal plasma flow). Such studies often indicate depression of function on one side in the salvageable patient, when all other means of discovering unilateral renal disease have failed. They also establish the functional state of the good kidney, without a knowledge of which nephrectomy should never be undertaken.

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SUMMARIO IN INTERLINGUA

Constataciones Pyelographic in Morbo Renal con Hypertension Correlation Inter le Constataciones Pyelographic e le Resultatos de Tests del Renofunction Differential

Le autores ha correlationate tests de function renal con le constataciones pyelographic in 17 patientes hypertensive. Es-seva trovate que le densitate del substantia de contrasto supra le pelve renal non pote esser acceptate como indice de function. In omne le casos, con 1 exception, le excretion del substantia de contrasto esseva de bon densitate a ambe lateres in despecto del presentia de frappante depression functional uni- o bilateral. Aortographia esseva effectuate in 8 inter le 17 patientes. Le resultado identificava le ren responsabile in 7 casos e esseva equivoc in 1. Tests de function differential esseva de grande valor in le demonstration de morbo unilateral e del grado de compensation in le ren contralateral in certe patientes. Illos

monstrava clarmente qual casos esseva non-apte al tractamento chirurgic a causa de depression bilateral de function. Hypertension relationate con morbo renal unilateral esseva provate in 6 del 17 patientes. Omne iste 6 pote hodie esser considerate como curate: 5 post nephrectomia e 1 post nephropexia con graffo a shunting como correction de un aneurysma.

Si le hypertension non es satis perenne pro haber devenite fixe, illo es curabile in cautemente seligite patientes per nephrectomia o reconstructive chirurgia arterial. Le un o le altere typo de obstructive morbo arterial es usualmente presente. Ischemia de ancora viabile histos renal es probabilemente responsabile pro le initiation del hypertension.



Clinical Evaluation of Radioactive Chrome Phosphate in the Control of Malignant Pleural and Ascitic Effusions

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MALIGNANT EFFUSIONS are an ever present problem confronting physicians treating patients with far advanced metastatic cancer. During the past eight years several agents have been utilized in an effort at palliation and control of such effusions. The use of radioactive colloidal gold (Au^{198}) was reported by Müller (18) in 1949. Chrome phosphate utilizing radioactive P^{32} was investigated by Jaffe (8) in 1950, and in 1956 Siegel and her colleagues (22) described the use of radioyttrium (Y^{90}).

difference has not, however, proved to be significant in clinical application. The colloidal suspension of radioyttrium 90 apparently is less stable than colloidal gold (19).

It would appear that the systemic absorption of none of the compounds is clinically significant. There has been some concern regarding chrome phosphate, but the total amount of radioactive phosphorus in the circulating blood is believed never to exceed 1 per cent of the administered dose, and urinary excretion amounts to approxi-

TABLE I: CHARACTERISTICS OF RADIOACTIVE AGENTS FOR CONTROL OF MALIGNANT EFFUSIONS

Agent	Particle Size	Systemic Absorption	Half-Life (Days)	Beta Energy (Maximum)	Beta Range (Water)	Radiation Hazard
Chrome Phosphate	Variable 0.2-25 micra	Negligible Less than 4 per cent dialyzable	14.3	1.72 Mev	8.0 mm.	Slight
Colloidal Gold	Uniform 0.003-0.007 micra	Negligible	2.69	0.98 Mev	3.8 mm.	Moderate
Radioyttrium	Variable	Negligible	2.54	3.2 Mev	11.0 mm. (tissue)	Slight

Table I compares briefly the characteristics of radioactive agents used for the control of malignant effusions. It is to be noted that chrome phosphate as produced at present shows a wide variation in particle size. In most of the commercially available solutions, however, approximately 85 per cent of the particles measure from 1 to 5 micra. There is experimental evidence that the larger particles are less readily absorbed (5). Radioactive gold exhibits a uniform particle size and is a more stable colloidal solution. Lahr (16) has noted that the deposition of gold 198 on the pleural surface of rats is more uniform than that of chrome phosphate. Furthermore, the clumping which is seen in chrome phosphate solutions has suggested the possibility of uneven irradiation of the pleural or peritoneal cavity. This

mately 5 per cent in eleven days. It is worthy of note, however, that Root (20) reported a case in which 12 per cent appeared to be present in the liver after intraperitoneal administration.

The longer half-life of chrome phosphate is an obvious advantage in that a constant supply may be kept on hand; a delay of one day in delivery, due to the uncertainties of transportation, is not significant with this isotope. The longer half-life, of course, also allows for more prolonged irradiation of tumor cells. If, however, radiation sickness has occurred, that too may be prolonged.

The maximum beta energy and range are perhaps not significant from the clinical standpoint. The average beta range in tissue is more important. For colloidal gold it is approximately 1 mm., for chrome

¹ From the Department of Radiology, Mercy Hospital, Pittsburgh, Penna. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

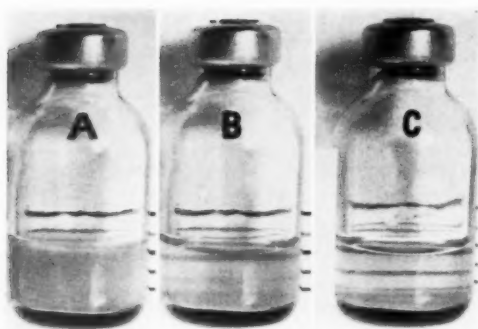


Fig. 1. Bottle of radioactive chrome phosphate. A. Immediately after thorough shaking. Note only lines above solution are visible.

B. One hour later the solution is beginning to settle out and the lines behind the solution are partially visible.

C. Four hours after shaking, the solution is almost completely settled out and the lines behind the bottle are readily seen.

At the end of 4 hours (Fig. 1, C) marked "settling out" has occurred and the lines behind the solution are now quite readily demonstrable. This "settling out" tendency has been disturbing to investigators, but clinical results indicate that the problem is not as serious as anticipated, probably because the transmitted vascular pulsations within the body cavities and the respiratory movements of the thoracic cage and diaphragm are continually agitating the solution and keeping it in a more uniform state.

In choosing the agent which he believes most suitable to control malignant effusions, the physician must consider several factors, some of which are shown in Table II. With radioactive agents it must be remembered that there is some delay in

TABLE II: COMPARISON OF RADIOACTIVE AND CHEMICAL AGENTS USED FOR CONTROL OF MALIGNANT EFFUSIONS

Treatment Agent	Effect on Fluid Formation	Systemic Side-Effects	Effect on Bone Marrow	Cost	Procurement and Handling
Chromic Phosphate	Some delay	Minor	Insignificant	Moderate	Easy
Colloidal Gold	Some delay	Minor	Rare hypoplasia	Expensive	Difficult
Radioyttrium	Some delay	Minor	None reported	Moderate	Difficult
Nitrogen Mustard	Immediate	Cytotoxic, Nausea	Frequent depression	Cheap	Available
Thio-tepa	Immediate	Less cytotoxic	Less frequent depression	Cheap	Available

phosphate 2.5 mm., and for radioyttrium 3.5 mm.

The gamma ray present in colloidal gold has been both praised and condemned. In our clinic we do not feel that the gamma radiation is therapeutically desirable in this application. It contributes significantly to the total-body radiation dose and adds to the difficulties of handling and storage. We prefer to obtain gamma rays from our cobalt-60 unit and have used such combined therapy in several cases.

Solutions of chrome phosphate have a tendency to "settle out" rather rapidly. Figure 1, A shows a solution of radioactive chrome phosphate immediately after thorough shaking. It will be noted that only the lines above the solution are visible. At the end of one hour (Fig. 1, B) the solution already shows "settling out" and the lines behind it are becoming more readily visible.

effect on fluid formation, during which time the radiation reaction is developing. It has been shown that the beta-ray skin reaction requires two to three weeks to develop. During this period it may be necessary for the patient to have one to three additional thoracenteses. Nitrogen mustard and triethylene thiophosphoramide have a more rapid effect, but there is still a delay during which it may be necessary for the patient to have an additional thoracentesis.

The radioactive agents have minor systemic side-effects, such as occasional nausea, which may be reduced with Thorazine or Compazine. Severe pleuritic or peritoneal pain of one to two days duration has been reported in a few patients in whom nitrogen mustard or radioactive gold was the agent (17). The nitrogen mustard compounds may also cause nausea, and they are cyto-

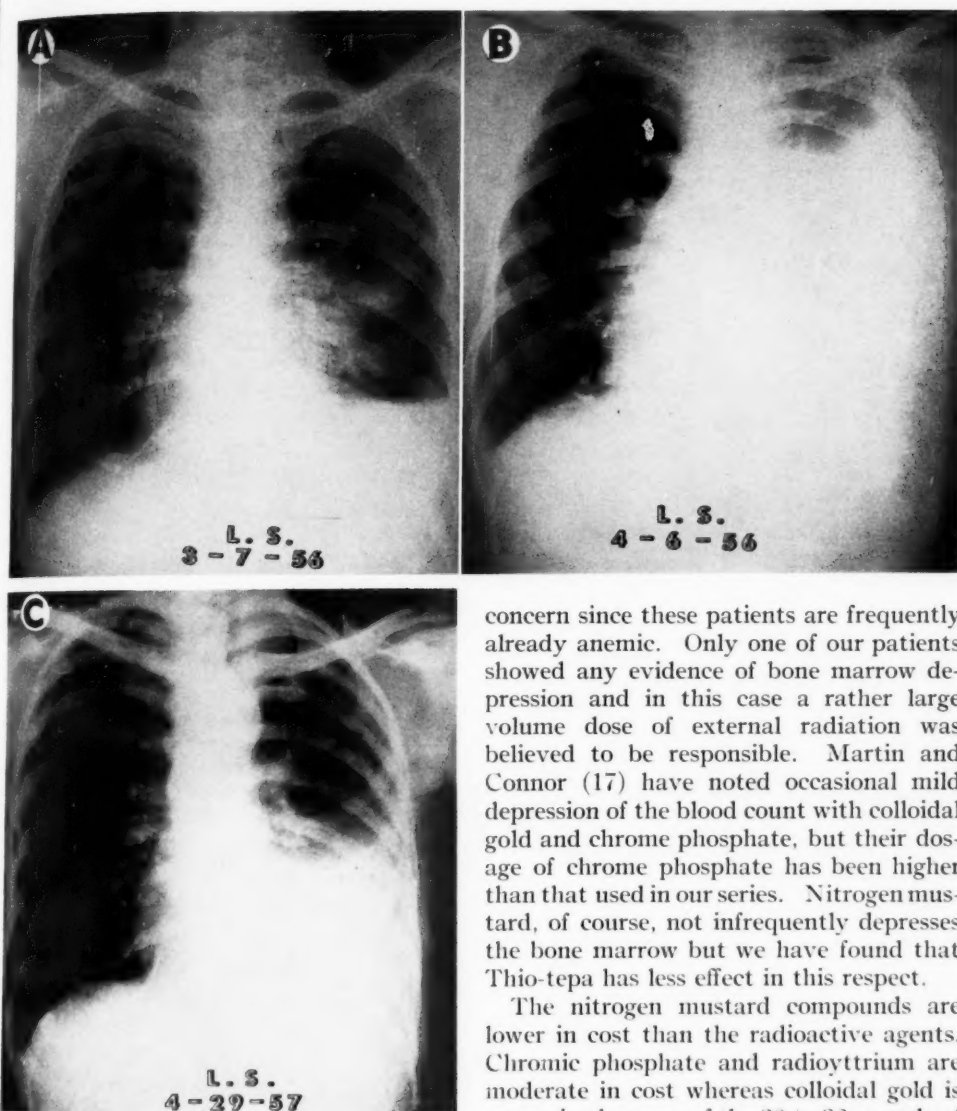


Fig. 2. Case 1. A. Chest roentgenograms made on March 7, 1956, six days after thoracentesis and instillation of chrome phosphate.

B. Chest study made on April 6, showing rapid reaccumulation of left pleural effusion.

C. Approximately one year later the chest is beginning to show reaccumulation of fluid and widespread bone metastases. The patient has had no additional thoracentesis.

concern since these patients are frequently already anemic. Only one of our patients showed any evidence of bone marrow depression and in this case a rather large volume dose of external radiation was believed to be responsible. Martin and Connor (17) have noted occasional mild depression of the blood count with colloidal gold and chrome phosphate, but their dosage of chrome phosphate has been higher than that used in our series. Nitrogen mustard, of course, not infrequently depresses the bone marrow but we have found that Thio-tepa has less effect in this respect.

The nitrogen mustard compounds are lower in cost than the radioactive agents. Chromic phosphate and radioyttrium are moderate in cost whereas colloidal gold is expensive because of the 30 to 32 pounds of lead which must be used for protection during shipping. Nitrogen mustard is, of course, readily available. Thio-tepa has been obtainable as an experimental drug and is now generally available. Chromic phosphate is readily obtained and kept on hand because of its long half-life.

No special protective and storing facilities are necessary for chromic phosphate, and only a plastic-shielded syringe is required for its administration.

toxic. Thio-tepa appears to be less cytotoxic than nitrogen mustard and is worthy of further clinical investigation.

The effect on the bone marrow is always of

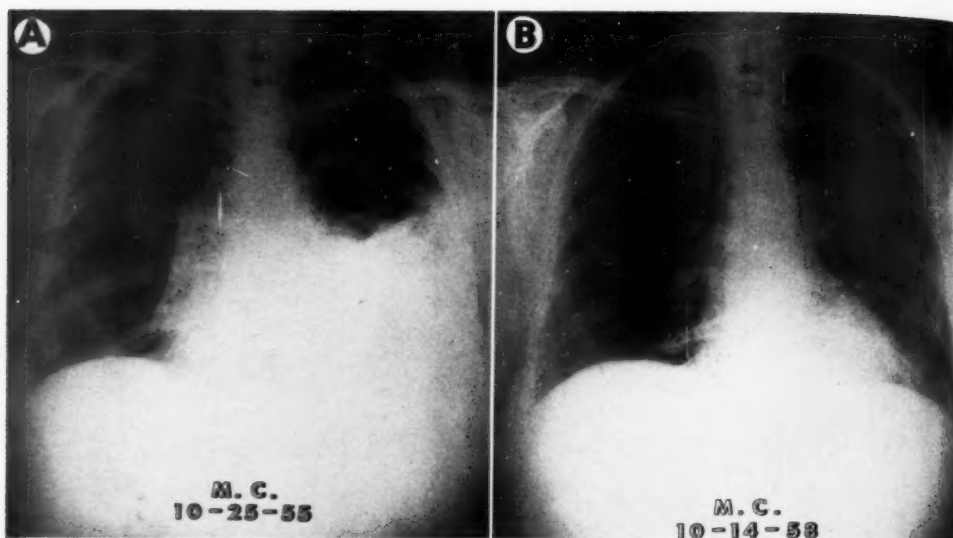


Fig. 3. Case II. A. Chest roentgenogram made on Oct. 25, 1955, showing left pleural effusion in patient with lymphosarcoma.
B. Chest study made three years after instillation of chrome phosphate. There is no evidence of pleural effusion.

Colloidal gold and radioyttrium have a short half-life and are therefore difficult to keep on hand. Because of its gamma ray, colloidal gold requires storage facilities with adequate protection. It is more difficult to handle without exposure to personnel, and special equipment is required for its administration. In the event of an accident, hypochlorite bleach powder must be used for decontamination. Only soap and water are necessary for decontamination of chrome phosphate.

The pure beta-ray emitters, chrome phosphate and radioyttrium, may be administered on an outpatient basis and many of our series were so treated. Thus, in the overall picture it would appear that chromic phosphate is the agent of choice among the radioactive drugs while Thio-tepa shows promise among the non-radioactive agents.

CASE REPORTS

CASE I: L. S., a 45-year-old woman with metastatic carcinoma of the breast, had a thoracentesis with instillation of 5 millicuries of chrome phosphate on March 3, 1956. There was a moderate amount of residual pleural fluid present (Fig. 2, A). On April 6, her chest roentgenogram (Fig. 2, B) showed evi-

dence of rapid reaccumulation of the pleural fluid and an additional thoracentesis was necessary.

Figure 2, C is a chest study made approximately one year later. No additional thoracentesis has been needed. The bones of the thoracic cage now show extensive metastases and the patient is just beginning to have some reaccumulation of fluid.

Comment: This case illustrates the reaccumulation of fluid during the latent period before the radiation reaction is fully developed. We believe it is important that the pleural cavity be as dry as possible three to four weeks following the instillation of the chrome phosphate. With apposition of the pleura, an obliterative fibrous pleurisy may develop and there is thus less chance for reaccumulation of fluid.

CASE II: M. C., a 66-year-old woman with lymphosarcoma, had an initial chest study (Fig. 3, A) on Oct. 25, 1955. A thoracentesis was done on Nov. 4, with instillation of 5 millicuries of chrome phosphate. A follow-up thoracentesis was performed on Nov. 21. The patient has had no additional thoracenteses since that time and three years later (Fig. 3, B) shows no evidence of significant reaccumulation of pleural fluid.

Comment: This case also illustrates the advantage of a follow-up thoracentesis.

If necessary, constant closed drainage should be used to allow the development of an obliterative pleurisy at the peak of the pleuritic reaction.

DISCUSSION

In our series of 60 cases in which radioactive chrome phosphate was used, the results were better in control of pleural than of peritoneal fluid. Fifty per cent of the patients with pleural effusions are believed to have been definitely benefited (Table III). This is an absolute figure,

TABLE III: PALLIATIVE RESULTS OBTAINED WITH CHROME PHOSPHATE IN MALIGNANT PLEURAL AND ASCITIC EFFUSIONS

	Pleural Effusions	Ascitic Effusions
Excellent	12	4
Fair	7	6
Died in less than a month	6	8
Unsatisfactory or incomplete follow-up	13	4
Known to have benefited	50 per cent	45 per cent

since those who died in less than one month and those who were lost to follow-up or in whom the follow-up information was incomplete were automatically considered unimproved. It is to be remembered that these patients may require one or two additional thoracenteses during the latent period in which the radiation reaction is developing, and this does not imply a poor result since the patient may go on to a long period of improvement. We do not consider the result fair unless there was no necessity for further thoracentesis for a period of two to four months. If no additional thoracentesis was necessary for four months or longer the outcome was considered excellent. With similar evaluation, this absolute figure is comparable to figures previously reported for colloidal gold (19).

Also shown in Table III are our results with the use of chrome phosphate in the abdomen. Forty-five per cent of the 22 patients showed some evidence of improvement. We are frankly not very impressed with these figures but believe that the low percentage of excellent results may be at least partially due to the low dose of 5

millicuries used in the peritoneal cavity, which has a much larger surface to be treated. Our decision to use the relatively low dose was originally motivated by the settling-out properties of chrome phosphate, the variation in particle size, and the occasional high uptake that had been previously reported in the liver. We now believe, however, that a dose of 10 millicuries should be used in the abdomen and that a dose of 5 to 8 millicuries may be employed in the chest. The higher doses will cause a slight increase in the frequency of mild side-reactions. It is of interest to note that, despite the low doses used in the abdomen, the results are similar to some of those reported by others using colloidal gold (7).

SUMMARY

It would appear to us that radioactive chrome phosphate is the agent of choice, in preference to colloidal gold and radioyttrium, in the treatment of malignant effusions. We prefer it to nitrogen mustard because of the generalized cytotoxic effect of the latter preparation. One of the newer nitrogen mustard compounds, *i.e.*, Thiotepa, is worthy of more extensive clinical investigation as a suitable addition to the to the armamentarium of the physician treating patients with malignant effusions.

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SUMMARIO IN INTERLINGUA

Evaluation Clinic de Radioactive Phosphato de Chromo in le Subjugation de Maligne Effusiones Pleural e Ascitic

Radioactive phosphato de chromo es considerate como le agente de election, preferibile a auro colloidal e yttrium radioactive, in le subjugation de effusiones maligne in patientes con avantiatissime canceres metastatic. Illo es a preferite mustarda de nitrogeno a causa del generalisate effecto cytotoxic de iste ultime. Un del plus recente compositos de mustarda de nitrogeno, Thio-tepa, merita un plus extense investigation clinic.

Es opiniate que un medietate de 38 patientes con ascites pleural, qui recipava

instillationes de 5 millicuries de radioactive phosphato de chromo, ha beneficiate ab iste tractamento (12 con resultados eccellente e 7 con resultados satis bon). Le mesmo valeva pro 10 de 22 patientes con ascites peritoneal qui esseva tractate in le mesme maniera (con 4 resultados eccellente e 6 resultados satis bon). Super le base de iste lor experientia, le autores nunc crede que le dosage usate esseva troppo micre. Illes recommenda que 10 millicuries es instillate in le abdomine e que un dose de inter 5 e 8 millicuries es empleate in le thorace.

The Diagnosis of Pericardial Effusion with Intracardiac Carbon Dioxide¹

JAMES H. SCATLIFF, M.D., ALFRED J. KUMMER, M.D., and ARNOLD H. JANZEN, M.D.

IN 1837 CORMACK (1) reported that he blew the contents of his twice-filled chest into the jugular vein of a horse and that the animal exhibited "only moderate signs of uneasiness." This probably represents the first time that the right heart of any animal experienced more than its usual quota of carbon dioxide. Needless to say, physicians have felt considerable uneasiness in the intervening one hundred and twenty years when any free gas arrived in the heart.

In the last two years intracardiac carbon dioxide has been shown to be of definite diagnostic aid in cardiovascular radiology. Experimental animal studies by Oppenheimer *et al.* (2) in 1955 revealed that relatively large amounts of this gas could reach the right heart and pulmonary circulation without producing embolic phenomena. Human application was first carried out by Stauffer (3), who visualized the heart valves and chambers in two infants. In the course of these studies Durant, Stauffer, Paul, and Oppenheimer (4, 5) found that carbon dioxide in the right atrium could be used to differentiate pericardial effusion from cardiac enlargement.

The limitations of plain-film examination in this problem are well known. Kymography may show blunting of pulsations in both entities, and fluoroscopy in the recumbent position may demonstrate widening of the base of the cardiac silhouette in both. Opaque angiography will reveal the presence of surrounding pericardial effusion but carries with it the risk of allergic reaction. Reliance on pericardiocentesis to establish the diagnosis entails the hazard of myocardial laceration and hemopericardium.

In order, therefore, to evaluate the carbon-dioxide method, a series of 22 patients have now been examined by the

authors. It is with the rationale, technique, results, and safety of intravenous carbon-dioxide insufflation that this paper deals.

RATIONALE

It has been pointed out that carbon dioxide is twenty times more soluble in blood than oxygen or air. This property of the gas allows the formation of a transient gas-blood level and serves as the crux of the method. It may be calculated that small intravenous injections of carbon dioxide, 50 to 100 c.c., alter the carbon-dioxide content of the blood approximately 5 to 10 volumes per cent, and this effect is of only several minutes duration. In this time the change produced in the blood pH is insignificant. This amount of carbon dioxide is equivalent to the amount of the gas formed in one minute during minimal exercise, such as eating or turning over in bed.

If a patient is placed in left decubitus (left side down, right side up), carbon dioxide, once in the right atrium, will rise and outline its uppermost surface. In this position the atrium is seen as a hemispherical shadow extending at its summit 4 to 5 cm. above the spine. The opaque shadow or band, as we have come to call it, outlined between the carbon-dioxide bubble and the overlying lung, consists of pleura, pericardium, and atrial wall. Autopsy measurements have shown that the width of these structures in the normal and enlarged heart averages 3 mm. With allowance for x-ray magnification and varying degrees of pericardial and epicardial fat accumulation the shadow should be no more than 5 mm.

In the presence of pericardial effusion the heart assumes a dependent position (4) and the fluid, if freely mobile and in sufficient quantity, widens the space be-

¹ From the Department of Radiology, Yale-New Haven Medical Center, New Haven, Conn. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

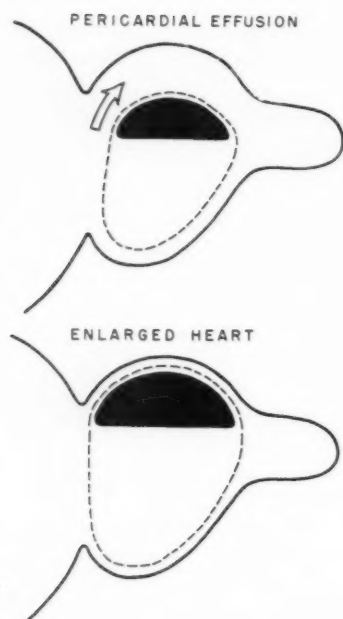


Fig. 1. Diagram of heart of patient in left decubitus position. Lower figure illustrates findings in an enlarged heart without pericardial effusion. The non-hypertrophied right atrial wall, pericardial and pleural coverings produce a thin opaque band between the intracardiac gas bubble (in black) and overlying lung. Upper figure shows how the opaque band (arrow) is widened as the heart assumes a dependent position and pericardial fluid moves between the right atrial wall and pericardial lining.

tween the pericardium and atrium (Fig. 1). The opaque band will then be of increased width. A similar widening, but usually of less degree, may be seen in pericardial thickening. In the large dilated heart the right atrial wall remains of normal size or its thickness is only slightly increased. It is possible in most instances, therefore, to differentiate between cardiac enlargement and significant pericardial effusion.

TECHNIC

Several methods of filming were used in the present series. Most of the patients were studied with the Fairchild cassette. Three were examined satisfactorily by cineradiography. Recently the technic recommended by Stauffer, with one or two 14 × 17-inch films taken immediately after the gas injection, has been successful.

When serial filming apparatus is employed, a fluoroscopic examination is first made in the left decubitus position. The right atrium is marked off on the back and anterior chest. The patient is then placed in front of the cassette and the central ray is directed through the chest at the atrial level. All films are made postero-anteriorly at 36 inches distance (Fig. 2).

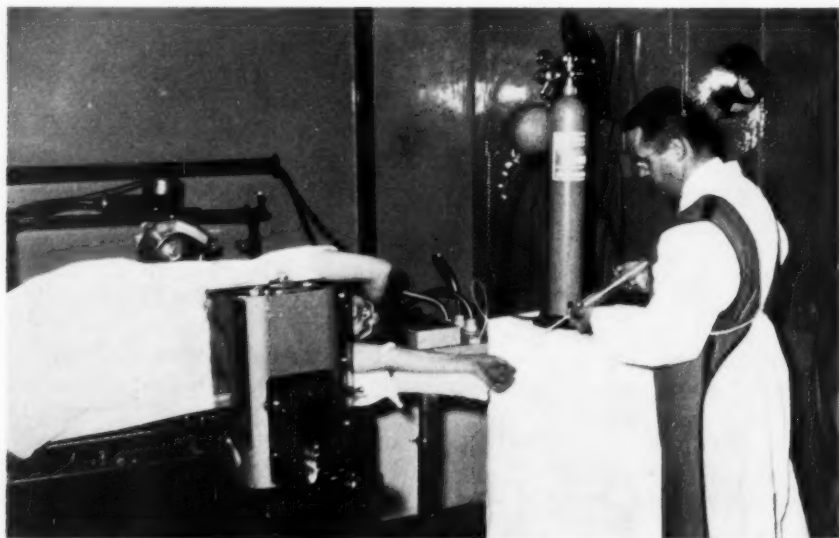


Fig. 2. Position of the patient, serial filming device, and carbon dioxide tank during examination.

A tank of 100 per cent carbon dioxide is attached to a 50-c.c. syringe through a 3-way stopcock (Fig. 3). An anesthesia bag and tubing serve to connect the tank and syringe. The tubing is wired snugly at all points of attachment to prevent possible air contamination. Following this, a 2-foot plastic sterile tube is added to the stopcock. The entire system is then flushed ten to fifteen times with carbon dioxide. An 18-gauge needle is placed in the left antecubital vein. The tubing is flushed again several times and then connected rapidly to the needle. A 50-c.c. injection of gas is made over a two- to three-second interval. Filming at a rate of one film per second is started at the beginning of the injection and continued for a period of fifteen to twenty seconds. During this time the patient has been instructed to use quiet, shallow respiration. At the conclusion of the examination he is kept in left decubitus position until fluoroscopy or a check film taken five minutes later shows absence of the gas bubble.

When the 5-inch Philips image amplifier is used, the patient is placed on a

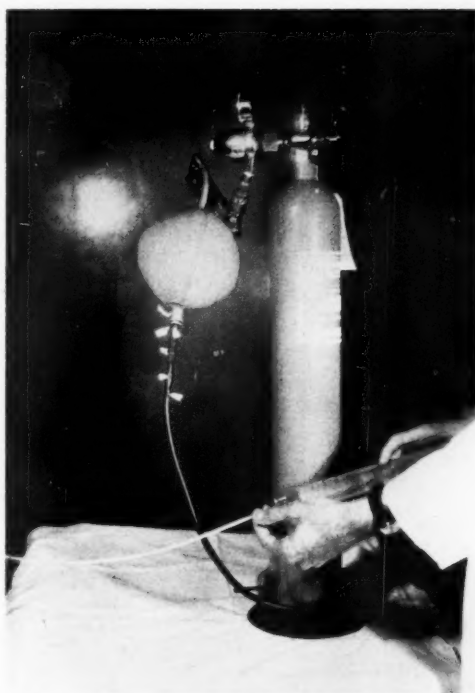


Fig. 3. Close-up of 100 per cent carbon-dioxide tank, tubing, and three-way stopcock. The rubber bag acts as a reservoir for the CO₂ prior to examination. White tabs are around wires used to hold rubber tubing snugly against glass fittings to prevent air contamination.



Fig. 4. Position of patient and image amplifier during examination.

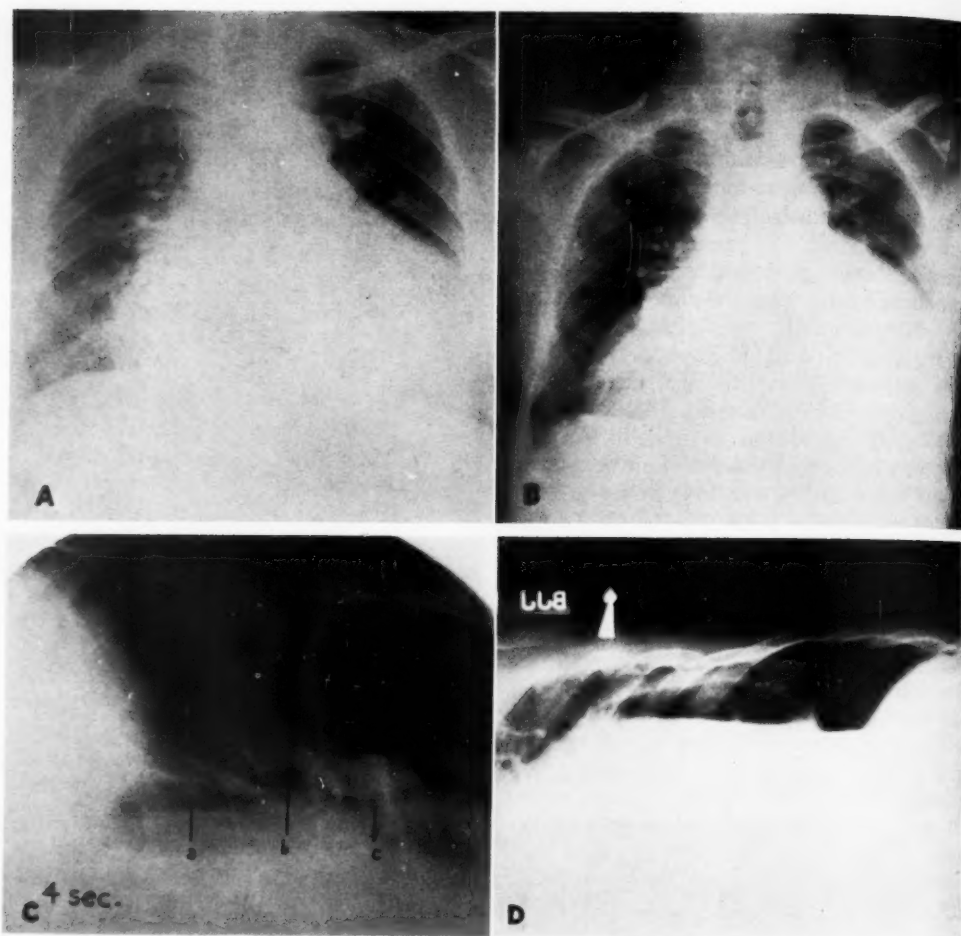


Fig. 5. Case 1: J. C. A. Chest film in 1955, interpreted as showing probable cardiac enlargement. B. Cardiac silhouette in 1957 indicating pericardial effusion. C. Intracardiac gas four seconds after injection. Gas in inferior vena cava at *a*, superior vena cava at *c*. Note marked increase in distance of right atrial gas bubble, *b*, from right lateral edge of cardiac silhouette, indicating very large pericardial effusion. D. Confirmation of pericardial effusion by instillation of air in pericardial sac. Note pneumothorax occurring at the time of the tap.

stretcher in front of the upright fluoroscopic table (Fig. 4). In order to bring the amplifier down to the level of the left atrium with ease, the chest is built up with pillows, and preliminary filming is done. The image of a metal marker of known size placed on the anterior chest over the heart is recorded on the film to correct for magnification. The fluoroscopic carriage is lifted while the needle is inserted and the tubing is connected. The amplifier is swung back into position

rapidly, and the injection is observed and filmed simultaneously.

RESULTS

The following cases serve to highlight the value and diagnostic acceptability of this technic. The patients were studied by fluoroscopy for cardiac pulsations and, initially in the series, kymography was carried out. The cardiac contours were evaluated in the erect and recumbent positions and confirmatory 14 × 17-inch

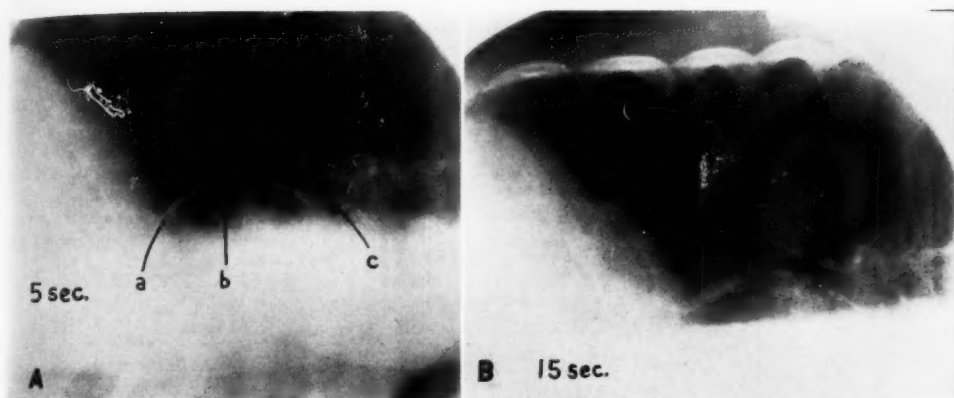


Fig. 6. Case II: M. W. A. Gas-blood level in right atrium *b*, at five seconds after injection. Thin opaque band at *a*, indicates only cardiac enlargement; *c* shows gas in right atrial appendage as indicated by trabecular pattern.

B. Gas bubble at fifteen seconds after injection, moderately diminished in size. Opaque band appears thicker due to different phase of respiration. The shadow of the inferior arc may at this time be made up in part by right ventricular wall.

films were taken. In the majority of the cases the resulting information and associated clinical data were thought inconclusive and the patients then became candidates for carbon-dioxide examination.

CASE I (Fig. 5): J. C., a 67-year-old male, had been treated for recurrent congestive failure over a ten-year period. His cardiac disease was thought to be primarily on a hypertensive arteriosclerotic basis. In 1955 a chest film was interpreted as consistent with generalized cardiac enlargement. In 1957 the cardiac silhouette showed further overall enlargement. The sagging lower angles of the heart, however, suggested pericardial effusion.

Fluoroscopy showed feeble pulsations of all cardiac margins and there was greater fullness of the cardiac shadow when the patient was prone. The first carbon-dioxide injection outlined the superior and inferior vena cava, but a definite gas-blood level in the right atrium could not be ascertained. A second injection, of 100 c.c. of gas, showed a small hemispherical area of radiolucency which appeared centrally placed inside the right cardiac outline. The distance between the cardiac gas shadow and overlying lung parenchyma was markedly increased, measuring 4.5 cm., indicating the presence of a very large effusion.

Subsequent pericardial tap yielded only 160 c.c. of fluid. Instillation of air at that time, however, disclosed considerable residual effusion. The patient would not submit to further pericardiocentesis and at postmortem examination, two months later, 3 liters of fluid were found in the pericardial sac. Moderate cardiac hypertrophy and dilatation were also present. The right atrial wall was of normal thickness.

CASE II: M. W., a 29-year-old Negro female, had been well until five months following a full-term twin pregnancy. Progressive congestive heart failure and cardiac enlargement then became apparent on serial roentgen studies. The blood pressure was slightly elevated, the highest reading being 135/95 mm. Hg. The range in the third trimester of her pregnancy had been 110-125/60-80 mm. Hg. There was no antecedent history of rheumatic or hypertensive heart disease and no murmurs could be heard. A prenatal roentgenogram had shown a normal cardiac outline. Fluoroscopy now revealed generalized enlargement of the heart in a somewhat globular fashion. No alteration in the cardiac outline could be demonstrated with change from the erect to supine position. Kymography showed a decrease in the amplitude of pulsations along the heart margins, as well as blunting of the waves. In view of the cardiac enlargement since the prenatal film and the equivocal rise in blood pressure, the presence of pericardial fluid was considered. Sixty cubic centimeters of carbon dioxide filled the right atrium satisfactorily and a right atrial band of normal gauge was seen (Fig. 6). An opaque hemispherical density appearing through the gas shadow was thought to represent the blood-filled left atrium. Gas also outlined the trabeculated right atrial appendage. With the absence of demonstrable pericardial fluid, the roentgen diagnosis of generalized cardiomegaly was made. The clinical diagnosis at present is probable myocarditis of undetermined etiology.

It would appear then, as seen in the cases cited, that the differentiation of a normal atrial band and generous effusion is not difficult. There is a zone, however,

roughly between 5 and 20 mm., which may represent pericardial effusion, pericarditis, or both. There are several features in the films, however, which may help differentiate these entities, as illustrated in the following cases.

CASE III: E. C., a 40-year-old Negro, had been seen in 1956 with complaints of chest pain, night sweats, and weight loss. These symptoms and the

heart with change from the supine to the erect position. Carbon-dioxide studies showed an opaque band measuring 6 mm. at the summit and 17 mm. at its inferior arc. In this instance the gas bubble (Fig. 7) occupies an eccentric position in relation to the larger opaque shadow. This is caused by pericardial fluid widening the space between heart and diaphragm but not present in sufficient quantity to cover the top of the atrium. Pericardiocentesis produced 400 c.c. of bloody fluid. Smear and culture of this fluid were again negative for acid-fast

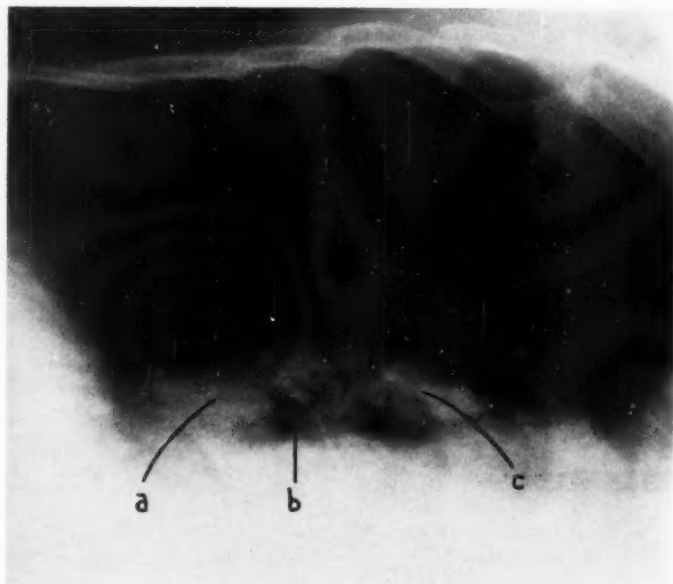


Fig. 7. Case III: E. C. Right atrial gas shown at *b*. Note disparity of size of inferior arc of opaque band at *a* and superior arc at *c*, indicating pericardial effusion.

associated history of close contact with an active tuberculous patient initiated a tuberculosis work-up. The P.P.D. reaction was positive. The chest films showed only a primary calcified granulomatous complex. Sputum cultures, as well as guinea-pig inoculation, were negative.

The patient was admitted to the hospital later in the year for multiple fractures of the extremities. He ran a persistent low-grade temperature, and re-filming of the chest showed an increase in the size of the cardiac silhouette. This was interpreted as consistent with either pericardial effusion or generalized cardiac enlargement. A pericardial biopsy was performed and 10 c.c. of serous fluid was evacuated at the same time. The fluid was negative on culture, and microscopic sections of the pericardium were normal.

In the course of several weeks the cardiac shadow continued to enlarge. Fluoroscopy showed normal pulsations, preservation of the normal general cardiac outline, and no alteration in configuration of the

organisms. The patient, however, responded dramatically to para-aminosalicylic acid and isoniazid with a rapid drop in temperature. In one month the cardiac silhouette had returned to normal.

CASE IV: O. F., a 29-year-old Negro female, was admitted to Grace-New Haven Community Hospital in August 1957 with a three-month history of cough, recent chills, and fever, and two months of gradually increasing dysphagia. A pericardial friction rub was heard. Chest films showed an enlarged globular cardiac silhouette and left pleural effusion. Fluoroscopy demonstrated decreased pulsation along both heart borders. Carbon-dioxide examination revealed an atrial band of uniform thickness measuring 1.5 cm. (Fig. 8). This finding and the unchanging configuration of the band on serial films suggested solely pericardial thickening. Pericardial tap produced only 5 c.c. of sanguineous fluid. Subsequently a broncho-esophageal fistula developed. Sputum culture indicated the presence of acid-fast

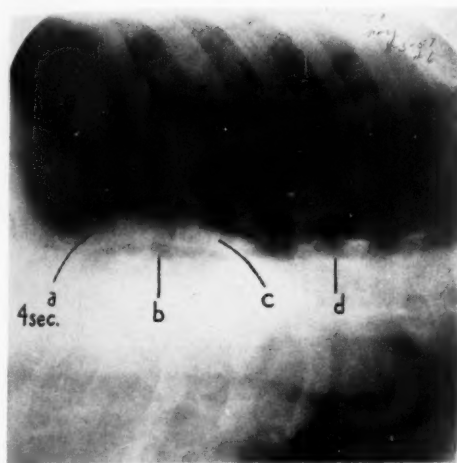


Fig. 8. Case IV: O. F. Right atrial gas bubble at *b* four seconds after injection. Opaque band of equal size, as shown at *a* and *c*, indicates pericardial thickening. Gas in superior vena cava at *d*.

organisms. At the time of fistula repair a pericardial biopsy showed granulomatous and fibrinous pericarditis. No evident effusion was present in the pericardial sac. Although no organisms were seen on a smear, the changes in the pericardium were assumed to be on a tuberculous basis. Antituberculous therapy was instituted, and in the succeeding six months the heart size returned to normal.

CASE V: R. G., a 54-year-old white male, was admitted to the West Haven Veterans Hospital in June 1958 with a two-week history of intermittent anterior chest pain. This had been of acute onset, characterized by a crushing feeling in the anterior chest, accompanied by pain radiating to the shoulders and jaws. The patient had experienced no prior symptomatology referable to the chest. A roentgenogram obtained two years earlier showed a heart of normal size. Physical examination on admission revealed decreased heart sounds and a pericardial friction rub. The blood pressure was within normal limits. An electrocardiogram showed ST-T wave changes compatible with pericarditis, although a recent coronary infarction could not be excluded. Chest films demonstrated a marked increase in heart size, suggesting pericardial effusion. Carbon-dioxide injection studies outlined an atrial band of 2.5 cm. Although the band was of uniform width (Fig. 9), it was felt to be excessively wide for pericarditis alone, and the diagnosis of pericardial effusion and pericarditis was made. Pericardial tap, however, revealed no significant fluid. In the course of several weeks roentgen studies showed marked reduction in heart size.

Three months later the patient returned to the hospital in acute congestive failure which did not respond to therapy. Autopsy showed evidence of old

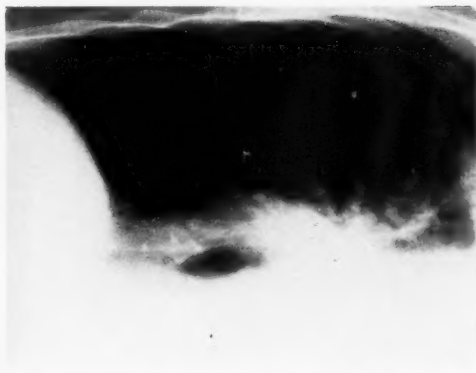


Fig. 9. Case V: R. G. Opaque band of uniform size but more than 2 cm. thick. Subsequent evidence obtained of pericarditis and probable effusion.

and acute myocardial infarction in the posterior wall of the left ventricle. The pericardium in the region of the right atrium was markedly thickened, there being no cleavage plane between pericardium and myocardium. These layers, as would be seen roentgenographically in the carbon-dioxide examination, measured approximately 1 cm. The discrepancy between autopsy measurements and the findings on carbon-dioxide injection, therefore, suggested that effusion as well as pericarditis had been present at the time of the earlier carbon-dioxide study.

Close analysis of the opaque band as seen in these 3 cases can help establish the presence of pericardial fluid or thickening. Asymmetry of the opaque band, found in Case III, as a clue to effusion has been described by Durant and his associates (4), who also reported a case similar to our Case IV. In their study the diagnosis of pericarditis was made on the basis of constant uniform thickness of the opaque band and flattening of the dome of the gas bubble by the relatively inelastic pericardium. When the opaque band exceeds approximately 2 cm., these differentiating signs would appear to lose their usefulness, as in our Case V, and the degree of fluid and/or thickening cannot be evaluated. It would seem unlikely, however, that a band exceeding 2 cm. would be produced by acute or chronic pericarditis alone. Further support for this view comes from the work of Figley and Bagshaw (6). These authors measured the same components of the atrial band

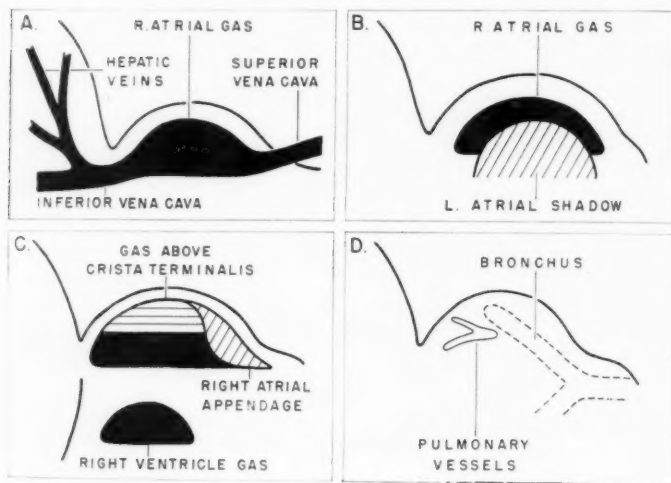


Fig. 10. Salient features of film interpretation.

- A. Reflux of gas into hepatic veins and inferior vena cava.
 B. Appearance of opaque left atrium in right atrial gas shadow.
 C. Compartmentalization of gas shadow in right atrium and gas under tricuspid valve in right ventricle.
 D. Spurious gas shadows produced by intermediate bronchus and pulmonary vessels.

as seen in opaque angiograms and listed values of 4.5–8.5 mm. for constrictive pericarditis. As seen in Table I the values

TABLE I: ATRIAL BAND MEASUREMENTS

	Angio- cardiography*	CO ₂
Normal	4 mm.	5 mm.
In pericardial effusion	10–15 mm.	12–45 mm.

* From Figley and Bugshaw (6).

for pericardial effusion in Figley's series exceed 10 mm., as in the carbon-dioxide series. The greater average measurement in the carbon-dioxide studies is due in part to case variation. Also, the opaque-angiography measurements were made in the supine position. The carbon-dioxide technic, employing the decubitus position, allows greater fluid accumulation between the right atrium and pericardium.

Several other interesting facets of film interpretation are compiled in Figure 10. Gas in several cases has refluxed into the hepatic veins. At times the blood-filled left atrium may be seen as an opaque density in the gas shadow. The gas bubble may appear compartmentalized. In this instance there appears to be a

radiolucency within an area of greater radiolucency, the two being sharply demarcated by a linear shadow running parallel to the gas-blood level. The upper radiolucency can be explained on the basis of gas collecting in a smaller volume of atrium above the crista terminalis. In several cases the heavily trabeculated atrial appendage has been outlined. Frequently a gas bubble under a tricuspid valve in the right ventricle was noted. Occasionally the superimposed intermediate bronchus or ramifying pulmonary vessels may mimic a small gas bubble and make evaluation difficult unless this shadow has been recognized on a preliminary film.

It must be remembered that occasionally the cardiac silhouette may be altered by invasive pericardial disease such as metastases, multiple myeloma, sarcoidosis, or amyloid infiltration. If these entities or benign or malignant tumors are present in the region of the right atrial wall, the gas bubble is displaced and a false positive finding of fluid is obtained. Lesions within the right atrium such as tumor or thrombus will also produce an abnormal outline in the opaque band. In one case of the series the superior arc of the band

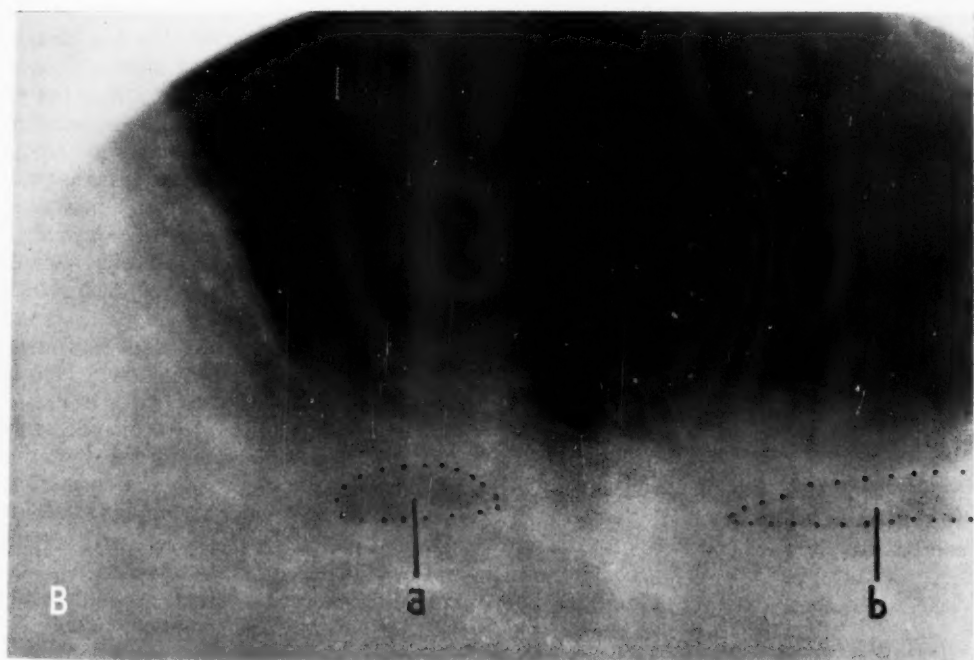
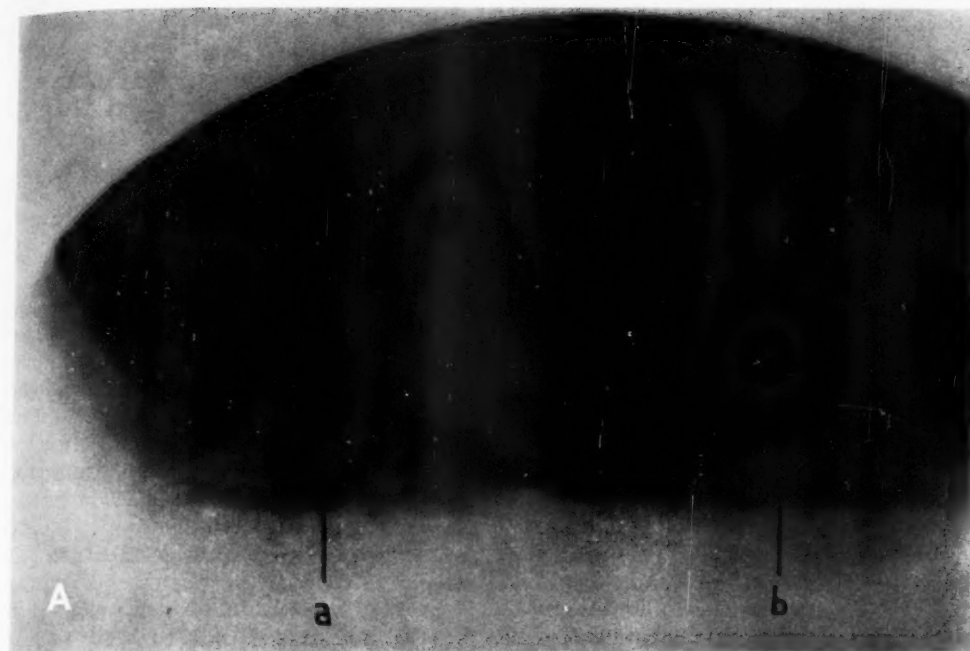


Fig. 11. Effect of diaphragm position on residual right pleural fluid.

A. During inspiration a normal opaque band over the right atrial gas bubble is seen at *a*; gas in superior vena cava at *b*.

B. In expiration right pleural fluid moves over gas in right atrium *a*; and gas in superior vena cava *b*.

was of abnormal caliber, the summit and inferior arc being of normal size. At postmortem examination, a thrombus was found filling the right atrial appendage, thus explaining the disparity of the arc measurements. When abnormalities of this sort are suspected, either from clinical data or a bizarre cardiac silhouette, opaque-contrast studies may be suggested. When these are feasible, opacification of all the cardiac chambers will give more information regarding the extent of the lesion than the localized carbon-dioxide study.

A final point in film interpretation to be stressed is that pulmonary infiltration in the vicinity of the right atrium or mobile right pleural fluid will obviate accurate assessment of the opaque band. An example of the latter is shown in Figure 11. This patient had both enlargement of the cardiac silhouette and right pleural effusion. Thoracentesis of the right chest prior to carbon-dioxide studies left only moderate blunting of the right costophrenic angle. It was evident, however, that fluid had shifted into the right mediastinal space at the time of the carbon-dioxide examination. Figure 11, A shows a normal atrial band during inspiration. In expiration (Figure 11, B), pleural fluid produces a false positive opaque band over the atrial gas bubble. The separation of the gas bubble in the superior vena cava from the lung indicates further that the fluid is in the pleural space rather than in the pericardial sac.

PATIENT SAFETY

Patient safety was of foremost concern in the use of this method. The experimental animal work of Oppenheimer and later reports in the German literature (7, 8) indicated that small quantities of carbon dioxide in the heart were well tolerated. Further reassurance was gained from the studies of Harvard and White (9) at this institution (Yale University). These investigators showed the diagnostic value and safety of carbon dioxide in the retroperitoneal space by injecting carbon

dioxide intravenously in dogs, at the rate of 100 c.c. per minute to a total of 10,000 c.c. with no demonstrable effects. This rate of administration of gas is, of course, slower than in the human studies. It does indicate, however, that sustained delivery of small amounts of free gas are well tolerated.

A major problem arose early in the case series concerning the degree and danger of diffusion of oxygen and nitrogen into the carbon-dioxide bubble once the bubble was inside the atrium. Because of this possible contamination, it was decided initially to turn the patient into the supine position at the conclusion of the examination, usually twenty to thirty seconds after the injection. It was felt that in this way the remaining free CO₂ would be dispersed in the capillary bed of the lungs. One of 15 patients manipulated in this fashion was the only one in the entire series in whom any complications in the use of the carbon dioxide technic were manifested. In this case an episode of paroxysmal coughing lasting for thirty minutes developed immediately after the patient had been turned on his back. It was unaccompanied by dyspnea, hemoptysis, or chest pain. Chest films taken immediately and over a period of several days showed no evidence of pulmonary infarction. This patient had been admitted for signs of right heart failure and persistent upper respiratory infection. It is known that when patients with chronic lung disease breathe increased amounts of carbon dioxide, severe coughing may result, presumably due to the irritative effect of the weak carbonic acid formed on the diseased bronchial mucosa. It is highly probable in the case cited that the carbon-dioxide bubble, when it reached the pulmonary circulation, was not evenly distributed in the capillary bed. An increased amount of carbon dioxide diffusing into a localized area of lung with pooled secretions could adequately explain this patient's symptoms.

After this experience, the rate of reduction of the gas bubble in the atrium

was reviewed and found to be relatively slow in some instances. In Case II, for example, the gas bubble was only moderately diminished in size after fifteen seconds (Fig. 6). This was found to be true in varying degrees in 9 of 16 cases; in 1 case the bubble was reduced by only one-fifth of its maximum size twenty-eight seconds after the injection.

The recognition of the persistence of the carbon-dioxide bubble, and Oppenheimer's (2) report of values of 10 to 20 per cent oxygen replacement of the bubble in the left heart one minute after injection, prompted analysis of the gas bubble in the right atrium of laboratory animals. Two dogs of moderate weight were anesthetized with Nembutal and placed in the left decubitus position. A cardiac catheter attached to a saline drip was placed in the right atrium. The position of the catheter and delivery of 100 per cent carbon dioxide into the atrium by this means was observed and filmed with cineradiographic techniques. Unfortunately, in both dogs a 50-c.c. gas bubble went into solution so rapidly that an adequate gas sample could not be withdrawn. For this purpose 200 c.c. of gas was required. Samples were withdrawn at forty-five seconds when the bubble had been reduced to approximately one-half its initial size. Further rapid solution of the bubble permitted only one sampling. The samples were collected with a mercury tonometer and analyzed with a Scholander apparatus. In those regarded as being collected without significant contamination, considerable variation in nitrogen content was found between two bubbles placed in the same dog and between the 2 dogs. There were 23 and 44 per cent nitrogen in the first animal and 14 per cent in the second. It is possible, in view of this variation, that contamination occurred during sampling. However, in each instance the oxygen content of the bubble was approximately 1 per cent and the carbon dioxide content varied indirectly with the nitrogen, ranging from 84 per cent to 55 per cent. It is

probable that variations in the blood-gas surface relationship from bubble to bubble and uneven mixing of the diffusing nitrogen in a short period could account for these differences. The important fact does appear that significant amounts of nitrogen can diffuse into the carbon-dioxide bubble rapidly.

The femoral artery pressure tracings were also of interest. With the large amounts of gas used (150-250 c.c.) the pulse pressure was reduced by one-third of its pre-injection value. This occurred on the average of one and one-half minutes after delivery of the gas. Return to normal pulse pressure took place rapidly, approximately two minutes after injection. A return to the pre-injection femoral artery pressure, however, required three and a half to four minutes. When the dogs were in the supine position, 100 c.c. of gas placed in the pulmonary artery per catheter reduced the diastolic femoral artery pressure by one-half and the pulse pressure became zero in one minute. A restoration to the pre-injection pressure occurred in three to four minutes. When 50 c.c. of carbon dioxide was used, a similar lowering of the arterial pressure was found, but to a less degree and over a shorter period of time. Electrocardiographic tracings taken during this time showed no irregularities.

These results would seem to indicate the possibility of embolism or hypotensive effects developing when the patient is turned on his back. Consequently our patients are now maintained in the left decubitus position after injection. As Durant and Stauffer (4) have emphasized, this position serves as a natural gas trap, preventing access of gas to the outflow tract of the right ventricle. At present a film is taken or fluoroscopy is performed five minutes after injection to check for residual gas. In the last 7 patients in this series no gas has been observed after this time and no complications have been experienced following the procedure.

In order to exclude significant contamination of the carbon dioxide employed,

a survey of our commercial hospital tanks was carried out. In each instance the degree of recorded contamination was within the limits of statistical error or insignificant. The survey showed:

Tank in use three months.....	99 per cent CO ₂
Fresh tank.....	97 per cent CO ₂
Tank in use three months, tubing, and 50-c.c. syringe.....	98 per cent CO ₂

Possibly the only contraindication to CO₂ examination is the presence of a known large intracardiac shunt. If, however, the patient is maintained in left decubitus throughout the period of gas reabsorption by the right atrial blood, it is highly improbable that the small quantity of gas administered could be directed through a septal shunt. Also, as indicated by the experimental work in animals by Oppenheimer (2), small amounts of carbon dioxide in the left heart are apparently innocuous.

A further limitation of the technic is, of course, the necessity of placing the patient in the left decubitus position and maintaining that posture for at least ten minutes. The patient in severe congestive failure or advanced pulmonary disease may be unable to co-operate satisfactorily for adequate filming. In 2 patients in this series, however, moderate and extensive pulmonary fibrosis and emphysema were present and the examination was well tolerated. If chronic lung disease or congestive failure is found, a preliminary trial in the left decubitus position may be made to check for development of unusual pulmonary complaints. If these do occur during an examination they may be attributed to the patient's posture rather than to the effects of carbon dioxide.

Finally, in the evaluation of patient safety it may be asked if this method has any advantage over opaque contrast materials. Steinberg (10) has shown early development of pericardial effusion by opacification of all chambers of the heart. Conceivably, smaller amounts of opaque material can be used to visualize the right heart. Both these technics, however, carry with them the risk of allergic reaction

or sensitization. Ultimately the use of a non-allergic opaque agent and biplane angiography would be the procedure of choice. Until that time, the carbon-dioxide method has given every indication of being a simple, effective, and safe tool in the differentiation of pericardial effusion and cardiac enlargement.

SUMMARY

A series of 22 patients were examined by the intravenous carbon-dioxide insufflation technic in order to differentiate pericardial effusion and cardiac enlargement. Correlation of the findings with the clinical course or subsequent autopsy findings of these patients would appear to bestow high diagnostic acceptability on the procedure.

The method can be used with rapid filming devices or the usual equipment of a general radiological department if several features of diagnosis described are kept in mind.

The examination can be performed easily and appears to be without hazard in the co-operative patient.

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SUMMARY IN INTERLINGUA

Le Diagnose de Effusion Pericardial, Effectuate per Medio de Intracardiac Bioxydo de Carbon

Vinti-duo patientes esseva examine per le technica de insufflation intravenose de bioxydo de carbon con le objectivo de differentiar inter effusion pericardial e allargamento cardiac. Si un patiente es positionate con le latere sinistre in basso e le latere dextere in alto, bioxydo de carbon que ha essite introduce per via intravenose ascende, post que illo ha attingite le atrio dextere, al superficie extreme de ille camera que alora es claramente delineate. In iste position le atrio es visibile como un umbra hemispheric attingente su culmine 4 a 5 cm supra le spina dorsal. Le banda opac inter le bulla de bioxydo de carbon e le suprajacente pulmon consiste de pleura, pericardio, e pariete atrial. Le largor de iste structuras in normal e allargate cordes amonta secundo constataciones necroptice a un valor medie de 3 mm. In le presentia de effusion pericardial, le corde se trova in position de-

pendente, e le liquido, si illo es liberemente mobile e presente in satis grande quantitates, allarga le spatio inter le pericardio e le atrio. Le banda opac ha alora un largor plus considerabile. In le caso de un grande e dilatate corde, le pariete dexteroatrial remane normal in su dimensiones o es solo levemente accrescite in su spissitate. Assi il es possibile in le majoritate del casos differentiar inter allargamento cardiac e grados significative de effusion pericardial. Le correlation del resultatos de iste technica con le curso clinic o le subsequente constataciones necroptice in le hic reportate casos supporta nostre fide in le accuratia diagnostic del procedimento.

Le methodo pote esser usate con dispositivos de radio-exposition rapide o le equipamento usual de un departamento de radiologia general. Le examine es facile a effectuar e pare esser sin risco in le caso de patientes qui es preste a cooperar.

DISCUSSION

Dr. Herbert M. Stauffer (Philadelphia, Penna.): It is naturally gratifying to find our idea for the carbon-dioxide visualization of the right atrial wall, developed originally from experimental studies, put to practical use by others.

I am sure that the intravenous injection of carbon dioxide is safe no matter what the position of the patient. The left lateral decubitus position, as employed by Dr. Scatliff, is actually the one indicated for prevention or treatment of air embolism.

Dr. Scatliff brought up the possibility of carbon dioxide entering the left side of the heart and the

arterial circulation through a septal defect. Our experimental studies with Dr. Oppenheimer are of interest in this connection, though not strictly comparable since the animals were anesthetized. Large volumes of carbon dioxide were injected into the distal segment of the cut carotid artery in dogs without observable ill effects. In other recent studies infarct-like lesions were produced chemically by selective injection into the coronary arteries of dogs (method of West); subsequent injection of carbon dioxide produced transient return of the electrocardiographic changes to normal.

Radiographic Findings in Renal Vein Thrombosis¹

NORMAN ZHEUTLIN, M.D., DIXON HUGHES, M.D., and BERNARD J. O'LOUGHLIN, M.D., Ph.D.

IN OUR CLINICAL experience we have encountered several instances of bizarre pyelographic patterns which have not been characteristic in their appearance and yet have the same pathologic etiology. When the various patterns were studied, it was determined that further investigation would be necessary to establish definitely the developmental processes involved. In all these cases occlusion of the renal vein was the common denominator.

In a review of the literature it was discovered that the roentgen aspect of renal vein occlusion has had little evaluation. The clinical syndrome and experimental details have been worked out and many case reports have been presented. Chronic renal vein thrombosis produces a nephrotic syndrome, which is the chief clue to diagnosis. Since definite changes can take place in the kidney and disturb the gross anatomy, roentgen findings should also be significant. With this in mind, we undertook a series of experiments to establish a roentgen-pathologic correlation.

The animal experiments consisted in the production of renal vein occlusion by surgical procedure and follow-up pyelography. In the first experiment an acute occlusion was produced by ligation of one renal vein. Catheters were placed in both ureters and retrograde pyelograms were obtained until the animal expired.

In order to simulate a chronic renal vein occlusion, a second experiment was carried out. A partial ligation of the renal vein was done, with a subsequent attempt to complete closure after three weeks.

In our third experiment a gradual closure of the vein was effected by a delayed action blood-vessel clamp made of steel, devised by Lowenfels *et al.* (15). The clamp is applied around a blood

vessel with the jaws held apart by a wrapping of absorbable surgical suture. As the suture is absorbed, the jaws of the clamp slowly occlude the vessel. This period of gradual closure serves to allow the development of collateral vessels and permits the organ to survive. The group of animals in the chronic experiment were submitted to periodic intravenous pyelography and evaluation.

Experimental ligation of the renal vein was first performed in 1843, by Robinson (21). Rowntree (22) in 1913 made an extensive study of the problem of using constrictive bands around the vessels, with ligatures. This resulted in albuminuria, hematuria, and the appearance of epithelial cells and casts in the urine. In 1921, Harrington (9) ligated the renal vein and made the following observations: (a) Symmetrical atrophy of the kidney occurred after complete sudden occlusion. (b) Partial venous collateral circulation to the kidney was established, chiefly by means of the ovarian or spermatic, suprarenal, and lumbar veins. (c) The collateral system was not capable of assuming the function of the renal vein. (d) Ligation of the renal vein in a dog may cause the kidney to rupture.

The electrolyte and water excretions and renal hemodynamics during congestion from caval obstruction were studied extensively by Farber and his associates (8). They noted a tendency of the blood pressure to fall slightly, and that the urinary excretion of electrolytes and H₂O was reduced.

The clinical syndrome of renal vein thrombosis occurs most frequently in children, over 50 per cent of the patients being less than five years of age. Ileocolitis is considered the chief predisposing cause in the young. In adults the condition may be secondary to thrombosis

¹ From the Department of Radiology, University of California at Los Angeles, School of Medicine. Presented at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958. Supported by funds from the Ventura County Heart Association.

of the inferior vena cava with extension into the renal veins. Malignant growths of the kidney produce occlusion by direct invasion or by extrinsic pressure. In some reported cases primary renal disease, such as amyloidosis, glomerulonephritis, and malignant hypertension, has produced thrombosis of the renal vein.

In reviewing the literature on thrombosis of the renal vein, we were particularly impressed by the few instances in which a definite diagnosis was made. Even more confusing are the various roentgen findings described. It was hoped that a definite set of roentgen findings might lead to the correct diagnosis. This did not seem to be the case.

One of the initial reports of this syndrome was accompanied by pyelograms suggestive of polycystic disease (Derow, 6). These showed elongation of the infundibula, with pressure defects on the calyces and pelves. The kidneys were enlarged and regular in contour and over a period of one year underwent a further increase in size. Postmortem examination revealed edema of the interstitial tissue of the kidneys, which was considered the mechanism for the pyelographic pattern. In this case there was chronic vein thrombosis of long duration.

Campbell and Matthews (5) were able to make an antemortem diagnosis from the x-ray appearance in one of their 2 cases. Retrograde pyelograms were obtained and in the first case showed a large kidney with blotting out of all pelvic markings. In the second case there was diffusion of the medium throughout the kidney, as if the "injection was made into a mass of mush." These cases were relatively acute in character.

Melick and Vitt (17) showed a retrograde pyelogram in which the pelvis was poorly visualized, irregular in outline, and irregularly filled. The kidney, following the occlusion of the renal vein, became quite swollen and edematous.

In 1945, Abeshouse (1) published an excellent article on thrombosis and thrombophlebitis of the renal vein. He reviewed

the literature back to Rayer, who reported the first example in 1837, and collected a total of 228 cases. He also noted that the majority of patients were children under five years of age. One case with an abnormal pyelogram showing a markedly irregular outline of the pelvis and upper ureter was presented. The appearance was suggestive of pyelitis cystica and ureteritis cystica. Actually the deformity was caused by edema of the mucosa secondary to thrombosis of the renal vein. In this collected series of 228 cases the diagnosis was made clinically in 3 instances. The x-ray diagnosis was based on size of kidney and retrograde pyelographic findings. The intravenous pyelogram was not considered helpful. In 9 of the reported cases retrograde studies were performed and in 2 the diagnosis was made, and made early. The changes were as described above, consisting of an irregular outline and incomplete filling of the pelvis. As the thrombosis progressed, the edema became more extensive and eventually occluded the pelvis, which failed to fill on pyelography. If contrast material was forcibly injected into the pelvis, filling of the veins and parenchyma resulted, producing a picture simulating a neoplasm or incomplete filling with pyelovenous backflow.

Regan and Crabtree (20) in their analysis of 94 cases of renal infarction found 71 instances of arterial infarct, 20 of venous infarct, and 3 of trauma. In 4 cases in this series retrograde pyelographic studies had been made, all showing some distortion.

Isolated case reports state that intravenous pyelography usually shows an absence of kidney function (Warren *et al.*, 25; Kaplan *et al.*, 13; Hasson *et al.*, 11). Others have reported normal intravenous pyelograms. Venography has been recommended as an aid to the diagnosis (10), the thrombosed vessel being visualized on an inferior vena cava study.

The varied findings described are not incompatible with the disease. It is possible to postulate different degrees of progression in vein thrombosis, producing



Fig. 1. Case I: Intravenous pyelogram showing an enlarged left kidney with distortion of the collecting system, simulating a "polycystic kidney." Renal vein thrombosis found at surgery.

gross changes in the kidney parenchyma. The x-ray image being a reflection of these pathologic phenomena, it is conceivable that a variable picture is produced. Thus, in acute thrombosis with massive infarction and perirenal hemorrhage, the intravenous pyelogram will show an enlarged nonfunctioning kidney. The retrograde pyelogram then shows the diffusion of contrast agent into the kidney mass with an amorphous distribution of density.

When one encounters a chronic, slowly progressive renal vein thrombosis, it is highly likely that adequate collateral circulation will take over the venous function, resulting in a relatively normal kidney. Between these two poles lie the changes produced by renal edema. Here one may see the "polycystic" deformity and the incomplete and irregular pelvis.

CASE REPORTS

CASE I (Fig. 1): E. G. O., a 60-year-old white female, gave a history of intermittent painless gross hematuria for three years. Prior to admission the patient began passing clots. Previous urological work-up was reported as negative. Physical examination revealed an enlarged left kidney. Urine showed a specific gravity of 1.020 with a trace of albumin and many red blood cells. Blood pressure was 168/50. A urogram was interpreted as showing a polycystic kidney. At surgery the enlarged kidney was found to have many tortuous venous plexuses over the surface. The renal vein was distended by a 3-cm. hemorrhagic yellow thrombus. The parenchyma showed adenocarcinoma. The kidney was removed and postoperative irradiation given. The patient is well at the time of this report.

CASE II: R. M., a 38-year-old white male, was admitted with a history of weight loss, fever, and



Fig. 2. Case III: Intravenous pyelogram showing enlarged kidneys with spreading of the collecting system due to renal edema secondary to renal vein thrombosis.

pain in the region of the right kidney. Physical examination revealed a palpable mass in the right flank. Blood pressure was 110/70. The specific gravity of the urine was 1.010, with 1+ albumin, casts, and white blood corpuscles. A nephrectomy was performed. Pathologic study showed a clear-cell carcinoma of the kidney with complete occlusion of the renal vein.

CASE III (Fig. 2): A 52-year-old white male was troubled with severe epigastric pain. About six years previously he had experienced "tearing pain" in the back while lifting a stack of mattresses. Since then there had developed varicose veins of the legs and abdomen, stasis dermatitis of the legs, hematuria and albuminuria leading to a diagnosis of "nephritis," and jaundice. One episode of peritonitis had occurred. Five years after the original complaint, the patient suffered a moderately severe attack of melena, with a diagnosis of "duodenal ulcer." This siege of pain at the level of the diaphragm was the worst yet experienced by him and required opiates for its suppression. Ascites was minimal.

Laboratory studies showed an essentially normal hepatic function profile and slight S-T segment depression on the electrocardiogram. Roentgenography revealed a normal gallbladder, bilateral renal edema, a huge azygos vein, and inferior vena caval obstruction, with extensive paravertebral and abdominal collateral pathways.

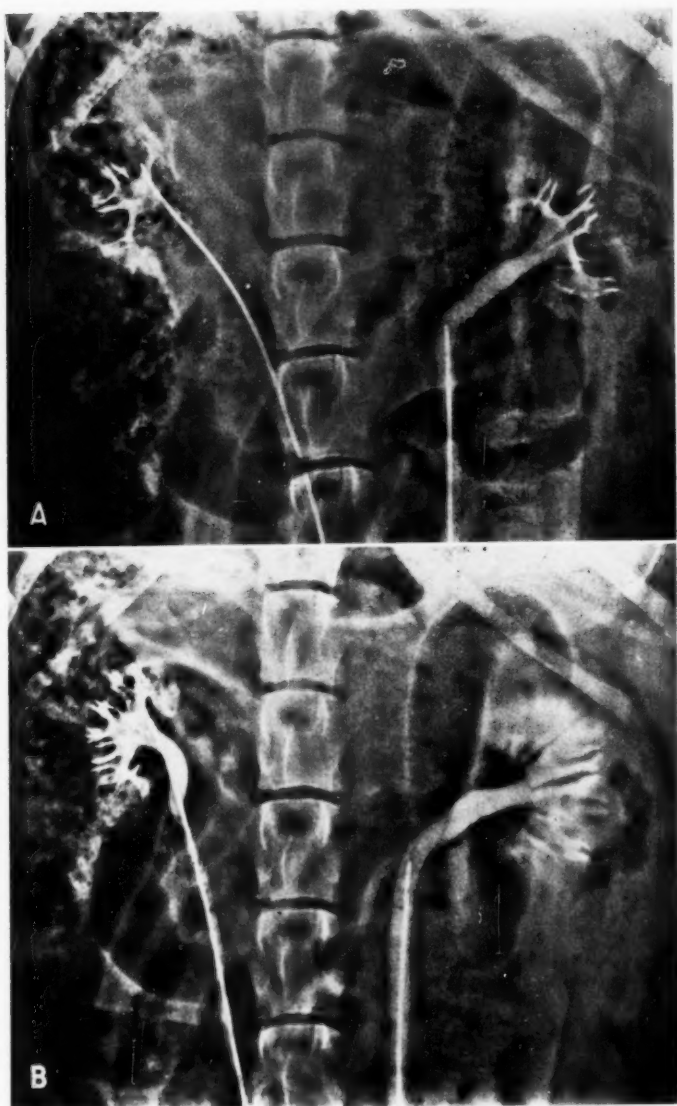


Fig. 3. Acute occlusion of left renal vein. A. Retrograde pyelogram made two hours following surgery, showing diffusion of contrast into parenchyma and dilatation of collecting system.

B. Film obtained five hours following surgery. More extensive changes demonstrated at this time.

SUMMARY OF EXPERIMENTAL DATA

An attempt was made to reproduce in dogs the changes observed clinically in renal vein thrombosis.

The first dog was operated upon after a routine intravenous pyelogram was obtained. The left kidney and both ureters

were exposed. Ureteral catheters were inserted from a point a few centimeters above the vesico-ureteral junction, and the renal vein was then ligated. The left kidney immediately became swollen and tense, and veins over the surface of the kidney and ureter became quite prominent. The ab-



Fig. 4. Left renal vein partially ligated ten days prior to intravenous pyelography. No change noted from examination made prior to surgery.

domen was closed, and the ureteral catheters were led out through the abdominal wound. Retrograde pyelograms (Fig. 3) made at hourly intervals showed increasing diffusion of the medium into the left kidney. Bloody urine was noted from the left ureteral catheter. The dog expired eight hours following the ligation. At autopsy the left kidney was found to be markedly edematous, with hemorrhage about the capsule of the kidney.

In the second dog a ligature was placed around the left renal vein so that approximately one-half of the lumen was obliterated. With the vein partially constricted, the abdomen was closed. Ten days later, an intravenous pyelogram (Fig. 4) revealed no change as compared to the preliminary pyelogram. Immediately after the second pyelogram was obtained, operation was again done, and an attempt made to occlude the renal vein completely. Unfortunately a great deal of difficulty was encountered, and the dog was sacrificed. The kidney and its vessels were examined. The renal vein proved to be patent, with a constriction at the site of previous partial ligation. Grossly there was no obvious difference in the appearance of the two kidneys.

In the third dog, a small steel spring clamp fashioned after the one described by

Lowenfels (15) was placed on the left renal vein and wrapped with plain 0 catgut to hold it open. Intravenous pyelograms were obtained at one- to two-week intervals. Although the clamp was seen to close slowly as time progressed, there were



Fig. 5. Chronic renal vein occlusion produced by metal clamp about the left renal vein. Film was made eight weeks after surgery. The kidneys appear unchanged.

actually no definitive changes in the appearance of either kidney. The kidneys were measured on the films by a planimeter, but no definite change in size could be detected. Since the clamp did not appear to be completely closed after eight weeks, surgery was again performed and the clamp was closed. In addition, another ligature was placed around the vein so as to insure its complete occlusion. Intravenous pyelography one week after the final closure still failed to reveal any significant change in the appearance of the kidney. Aortography showed no difference in the vascular pattern.

This third experiment was repeated with another dog and a similar clamp. Once again the pyelograms were normal in appearance, despite progressive closure of the renal vein over a six-week period.

SUMMARY

1. Renal vein occlusion was produced experimentally and the acute and chronic stages in the dog were studied roentgenologically.

2. Three cases of renal vein thrombosis in man are presented.

3. The diagnosis of renal vein thrombosis may be suspected roentgenologically by the demonstration of an enlarged kidney which on pyelography presents a "pseudo-cystic" appearance.

4. The literature on renal vein thrombosis is reviewed.

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SUMMARY IN INTERLINGUA

Constataiones Radiographic in Thrombose de Vena Renal

Le autores ha incontrate plure casos de un bizarre configuration pyelographic, non characteristic in apparentia sed con le mesme etiologia pathologic: Occlusion del vena renal. Le variate constataiones non es incompatible con le morbo: In acute thrombose con infarcimento massive e hemorrhagia perirenal, le allargate ren con absentia de function es vidite in pyelographia intravenose durante que le pyelogramma retrograde monstra diffusion del

agente de contrasto a in le massa renal con distribution amorpha de densitate. In chronic e lentamente progressive thrombose venose, adequate circulation collateral accepta, con alte grados de probabilitate, le function renal, e isto resulta in un ren que es relativamente normal. Inter iste duo polos se rangia le alterationes producite per edema renal. Hic on pote vider deformitate "polycystic" e un pelve incomplete e irregular.

Es summarisate quatro casos. Es reportate studios experimental. Effectos de ligation total del vena renal, de ligation partial, e de ligation a action retardate per medio de un crampa que se restringe lentemente super le vaso de sanguine

esseva studiate in canes. In le prime caso, le morte del animales eveniva in octo horas. Sub le conditiones del secunde e del tertie experimento, nulle significative alteration del apparentia del ren o de su configuration vascular esseva notate.



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Roentgenography and Biopsy in Mammary Cancer¹

SIMON M. BERGER, M.D., HELEN INGLEBY, M.D., and J. GERSHON-COHEN, M.D., D.Sc.

ROENTGENOGRAPHY OF the breast is a routine diagnostic measure accepted by only a few radiologists. One reason for reluctance to use this type of examination has been misunderstanding of the rationale. To bother with x-ray studies of the mammary gland, which is so accessible to physical examination and biopsy, seems superfluous. The low accuracy of roentgen diagnosis in earlier studies has also deterred surgeons and radiologists from adopting this procedure. The present communication will summarize our experience with breast roentgenography and its relationship to diagnostic surgical resection.

The cardinal roentgen criteria of carcinoma of the breast are:

1. The presence of an irregular or spiculated opacity, usually seen in scirrhous carcinoma. Advanced neoplasms are also accompanied by such secondary changes as distortion of breast architecture, thickening of the skin, nipple retraction, and increased vascularity.

2. A rounded opacity with localized notching or infiltration as in medullary or adenopapillary types of carcinoma.

3. Needle-point calcifications arranged in clumps, sometimes linearly and at other times widely scattered, frequently noted in "duct" carcinoma. We have encountered a few examples of this type of calcification when the carcinoma still remained *in situ*.

ACCURACY OF ROENTGENOGRAPHY OF THE BREAST

During the past two years, 536 patients from a total of 1,500 who had breast examinations underwent subsequent surgery, affording an opportunity to check the accuracy of the x-ray findings. Of 919 women reported to have benign breast lesions, 234 were operated upon, with confirmation

of the x-ray diagnosis in 229, or 98 per cent. Of 118 reported to have malignant mammary lesions, 108 were operated upon and 106 of these, or 98 per cent, proved to have cancer. In 173 women who had lesions reported as probably benign by the roentgenologist, 91 were operated upon and in 83, or 91 per cent, the condition was found actually to be benign. In another group of 122 women in whom the radiologist could make no definite diagnosis but suspected the possibility of cancer, 92 were operated upon and 48, or 52 per cent, were found to have malignant disease. Since this last figure is hardly better than guesswork, we have come to recognize that in about 10 per cent of all x-ray examinations the results are non-contributory and the radiologist is better advised so to state his findings. In other words, where the experienced radiologist can make a definite diagnosis of the lesion, whether it be benign or malignant, the percentage of accuracy is better than 95 per cent. For those lesions of which he is uncertain, but which he believes are probably benign, accuracy falls to 90 per cent; and finally, in about 10 per cent of all examinations, he is apt to find himself in a position where he cannot give a reliable opinion.

In another series of 209 consecutive cancers, 151 were diagnosed correctly by the surgeon, but the roentgenologist increased this number to 194. Thus the x-ray examination was responsible for a correct pre-operative diagnosis of 95 per cent instead of the 72 per cent of the surgeon. Even more important was the difference in the incidence of axillary lymph node metastasis in this supplementary group of cases diagnosed roentgenologically. Not only were smaller lesions discovered, but axillary lymph node metastases were present in only 13 per cent of this group in contrast to

¹ From the Department of Radiology, Albert Einstein Medical Center, Northern Division, Philadelphia, Penna. Accepted for publication in December 1958.

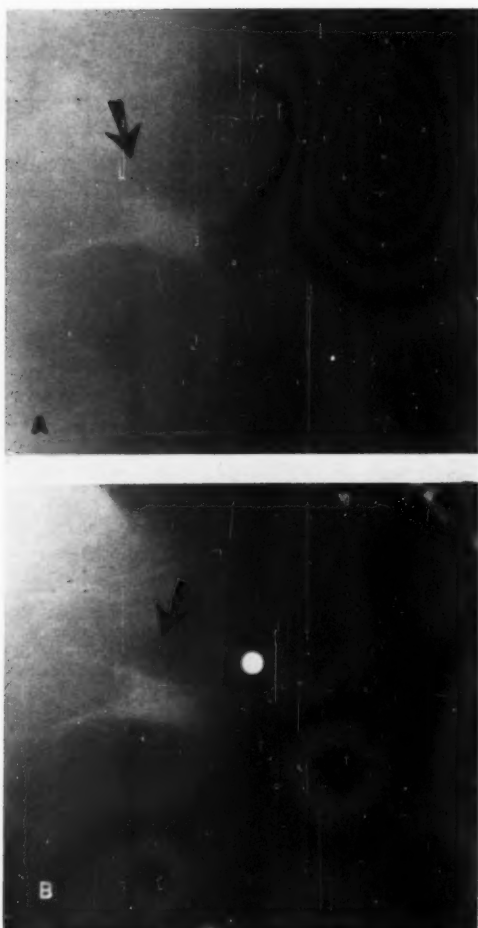


Fig. 1. Slow growth of a duct carcinoma in an asymptomatic survey patient aged 68 years. The irregular spiculated mass (A) was not appreciated by the radiologist. The patient returned for examination six months later and, though a mass was still not palpable, an x-ray diagnosis of "suspicious malignancy" was made. At the end of eighteen months and four subsequent examinations (B), though still no mass was palpable, a quadrant dissection revealed an intraductal carcinoma 1.5 cm. \times 0.8 cm.

64 per cent of those cases detectable by the surgeon.

GROWTH RATE STUDIES

Over the past five years, 16 cases were seen in which two or more successive x-ray examinations of growing mammary cancers were available. In some of these the lesion had been missed at an earlier x-ray study, due either to poor technic or inexperience.

Six of these cases have been previously reported in detail (1). The volumes were calculated by a simple formula from tumor areas measured on the x-ray film. The following interesting correlations appear: (a) All tumors under study grew at one of two distinct rates. In one group, intraductal and medullary adenopapillary cancers grew on the average, approximately 5 per cent per month (Fig. 1). In the other group, scirrhous and lobular cancers grew considerably faster, averaging 20 per cent increase in volume per month (Fig. 2). (b) Exponential growth was observed consistently. It was seen in the largest lesions, over 2.5 cm. in diameter, as well as in the neoplasm of 0.5 cm. (c) Cases in which three or more observations were available did not deviate significantly from the expected growth path. The last two findings substantiate the recent observations of Collins, who used successive x-ray examinations for study of tumor growth (2). Of the 16 patients studied, only 7 had a palpable tumor by the time of operation and the others, except 1 who refused surgery, were operated upon because of positive x-ray findings in the absence of a palpable tumor. Cancers as small as 0.5 cm. in diameter were detected by the x-ray examination (Fig. 3).

The x-ray diagnosis of "suspicious malignancy" in the absence of a dominant lump has sometimes led us into difficulties with surgeons who have refused to operate. In one patient followed from Nov. 12, 1956, to Feb. 8, 1958 (Fig. 4), it was noted that slight but definite gradual increase in the degree of calcification was occurring. At biopsy a diagnosis of adenocarcinoma, mainly intraductal, with a small area of stromal invasion, was made. The surgeon felt nothing remarkable, by-passed a frozen section, and did a local excision. At the time of the radical mastectomy, the axilla was not involved.

It is most important to emphasize that a roentgen study of the breast is no substitute for histologic diagnosis. A definite dominant mass with clinical signs indicating a neoplasm calls for surgical action;

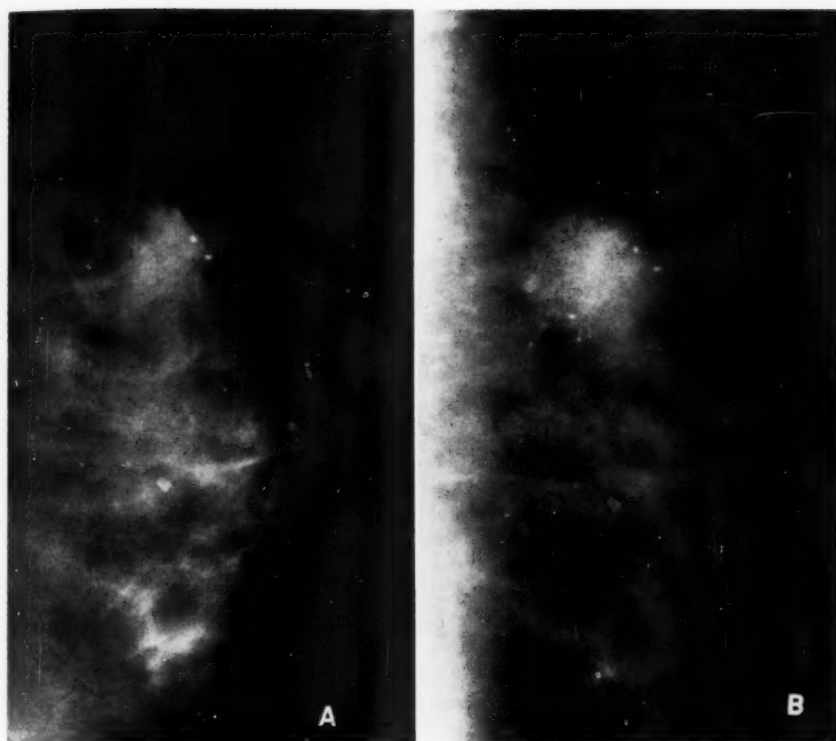


Fig. 2. Fast growth of a scirrhus carcinoma in a patient of 45 years. She was examined radiographically at time of admission for a nipple discharge from the right breast; no palpable lesion in either breast was detected by the surgeon or in the radiological department.

A. The opacity in the left breast was not appreciated roentgenographically. Six months later, the patient discovered a mass in the left breast. B. A second x-ray examination reveals considerable increase in size of tumor.

but omission of a preliminary x-ray examination may prove to be serious, inasmuch as roentgenography may show malignant disease in a location other than in the area of the palpable dominant mass; rarely in the opposite breast. An x-ray report of possible carcinoma in the absence of clinical signs also commands surgical attention. Finally, the status of a dominant mass in the face of an x-ray report revealing no evidence of malignancy must be established by a diagnostic surgical resection. Once it is clearly understood that x-ray examination is not a substitute for biopsy, the situations for which routine roentgenography becomes especially valuable are: (a) to confirm the nature of a dominant mass and to exclude the presence of a malignant lesion elsewhere in the breast; (b)

to exclude the presence of a malignant lesion in diffuse lumpy breasts; (c) in cases of occult cancer, with malignant axillary nodes or nipple discharge or a retracted nipple; (d) in asymptomatic breasts, to screen for small malignant lesions by periodic roentgen re-examination; (e) to study physiologic changes in the breast during and after the reproductive span of life.

DISCUSSION

X-ray diagnosis of breast disease is not unlike x-ray examination of the chest. Just as the radiologist has had to train himself to make reliable interpretations of chest films, so is experience required before he gains sufficient skill in the diagnosis of mammary disease. Once this experience has been acquired, the pitfalls of the pro-



Fig. 3. A tiny scirrhous carcinoma in an asymptomatic survey patient. No mass was palpable. A quadrant dissection revealed a tumor 0.4×0.5 cm. There were no axillary metastases.

cedure will be realized and the degree of accuracy can be fairly high. The most difficult types of breast to examine are that of the young adolescent virgin and that of the adult where the mammary tissue is very dense and compact. In such breasts, unless the x-ray findings are clear-cut, the radiologist is better advised to point out the limitations of his examination and to put the surgeon on guard against accepting the x-ray findings at face value. On the other hand, in the climacteric and atrophic breasts of the aged, with their increased fat content, the x-ray diagnosis becomes easier.

During the past two or three decades, the incidence of cancer of the lungs has steadily increased. While smoking might be one of the factors to account for overall increase in this phenomenon, it is our opinion that the keenness of the radiologist in searching out cancer of the lungs is probably more responsible than any other



Fig. 4. A nonpalpable carcinoma in an asymptomatic woman observed for fifteen months. A. Though we reported a "probable duct carcinoma," the surgeon decided to follow the patient clinically since there was no palpable mass. B. When surgery was finally performed, no mass was palpable. Because of this, a frozen section was not obtained. The neoplasm was mainly intraductal, with one tiny area of infiltration. The axillary nodes were not involved by metastasis.

single factor for the current prominence of this form of cancer. It is our conviction that, if surgeons come to use the x-ray examination of the breast as a routine procedure, the diagnosis of early mammary cancer will be made more frequently, and that more cases will be discovered without metastasis. Under these circumstances, the excellent surgery now universally practiced should result in much better mortality statistics than at present prevail.

SUMMARY

X-ray examination of the breast can achieve a high level of accuracy. With

clear-cut findings of a definite benign or malignant lesion, the accuracy is better than 95 per cent. When the x-ray findings are less clear-cut, the diagnosis is less reliable; this is true of approximately 10 per cent of all breast examinations, particularly in adolescents and some young adults. The older the patient, and the larger and fatter the breasts, the easier is the x-ray diagnosis.

Malignant lesions can be uncovered by roentgenography when they are relatively small. In these cases, the incidence of axillary metastases is less than in palpable lesions evident to the patient or the surgeon. In a series of 48 unsuspected or asymptomatic cancers detected by x-ray studies, the

incidence of axillary lymph node metastasis was only 13 per cent in contrast to 64 per cent in cases diagnosed at surgery. From a study of 16 cases with delayed operations, it was found that the x-ray examination was positive from one and a half to four years before the lesions became evident to the patient or the surgeon.

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SUMMARIO IN INTERLINGUA

Roentgenographia e Biopsia in Cancere Mammari

Le examine roentgenographic del mammas pote attinger un alte grado de accuratia. In casos in que le constatationes roentgenographic indica nettemente le presentia de un lesion benigne o de un lesion maligne, le accuratia excede 95 pro cento. Quando le resultatos roentgenographic es minus definite, le diagnoses es minus fidel. Isto es ver pro approximativemente 10 pro cento de omne le examines de mammas, specialmente in adolescentes e a vices in juvene adultas. Quanto plus avantiante in annos le patiente e quanto plus grande e grasse le mammas, tanto plus facile le diagnose roentgenographic.

Lesiones maligne pote esser detegite per roentgenographia quando illos es relative-

mente micre. In tal casos, le incidentia de metastases axillari es minus alte que in casos de lesiones palpabile que es evidente pro le patiente mesme o pro le chirurgo. In un serie de 48 nonsuspicate o asymptomatic canceres detegite per studios roentgenographic, le incidentia de metastases al nodos lymphatic axillari esseva solmente 13 pro cento, per contrasto con 64 pro cento in casos diagnosticate post intervention chirurgic. In un studio de 16 casos de operation retardate, il esseva trovate que le examine a radios X habeva essite positive a un periodo de inter un e medie e quatro annos ante que le lesiones deveniva evidente al patiente o al chirurgo.

Cyst of the Left Triangular Ligament of the Liver¹

ANDREW K. POZNANSKI, M.D., C.M.

CYSTS OF THE HEPATIC ligaments are relatively rare as shown by the fact that only 7 cases could be found in the literature. Four of these were in the falciform ligament (1, 6) and 3 in the ligamentum teres (2, 3, 4). No cases were described in the triangular ligaments.

The falciform ligament is a double layer of peritoneum that goes from the upper and anterior surfaces of the liver to the lower surface of the diaphragm and the back of the linea alba. Its line of attachment divides the liver into left and right lobes. The ligamentum teres is a fibrous cord running in the falciform ligament down to the umbilicus; it is the remnant of the umbilical vein. At the posterior portion of the upper surface of the liver, the left layer of the falciform ligament turns to the left and forms the anterior layer of a triangular fold called the left triangular ligament. This passes from the upper surface of the left lobe to the diaphragm (8).

Brown (1), in reviewing the reported cases of cysts of the hepatic ligaments in 1948, classified them as primary or secondary. The primary cysts can be of lymphatic origin, a developmental defect, or the result of peritoneal inclusion. Geist (5), discussing solitary nonparasitic cysts of the liver, included some cases in the hepatic ligaments. Various classifications of hepatic cysts have been devised, but that of Jones (7) is probably the most widely accepted.

In most of the cases described the cysts were large, some reaching the size of a child's head, and were usually palpable. The diagnosis was not made prior to surgery. In a few cases, roentgen studies of the gastrointestinal and renal systems were done, and in some instances showed extrinsic pressure on the gastrointestinal tract. The symptoms varied somewhat, but a

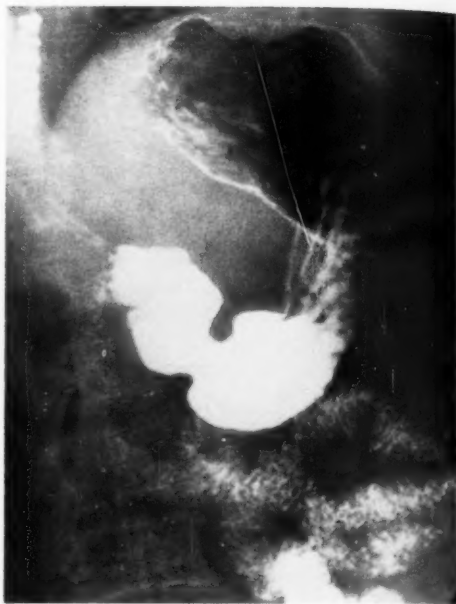


Fig. 1. The fundus of the stomach is distended with air and shows an indentation. There is also a localized elevation of the diaphragm.

number of the patients had pain in the epigastrium, indigestion, or a full feeling most marked after meals. One patient presented with acute symptoms as result of torsion.

Pathologically the cysts were essentially the same except for the case to be reported here, which contained hepatic tissue. There was a thin fibrous connective tissue wall in which muscle fibers were occasionally present. The cysts were in most cases unilocular with a smooth endothelial lining and contained a serous fluid that was clear or slightly cloudy.

CASE HISTORY

G. B., a 55-year-old white female, complained of heaviness in the epigastrium and burning epigastric pain. The history and physical examination were otherwise not contributory. Roentgen examination

¹ From the Department of Radiology, The Henry Ford Hospital, Detroit, Mich. Accepted for publication in January 1959.

of the upper gastrointestinal tract showed an indentation in the fundus of the stomach. The examination was repeated with air contrast and a defect measuring 2 to 3 cm. was demonstrated, with indentation of the fundus, and also a localized elevation of the diaphragm (Fig. 1). A pneumoperitoneum together with a barium examination of the stomach showed the mass to be separate from the stomach and from the left dome of the diaphragm, but



Fig. 2. Upright film with pneumoperitoneum, showing the mass to be separate from the diaphragm and from the stomach.

attached to the latter by fibrous strands (Fig. 2). Laminagrams in the upright position demonstrated this even more clearly. At subsequent laparotomy a $3.5 \times 2.0 \times 1.5$ -cm. mass was found within the left triangular ligament of the liver (Fig. 3). It consisted of 3 cystic cavities containing clear white fluid. Microscopically the cyst was lined by a single layer of flattened endothelial-like cells. The surrounding stroma contained myxomatous fibrous tissue, collagen, clusters of parenchymal cells resembling those of the liver, as well as some oval shaped structures which had the appearance of bile ducts.

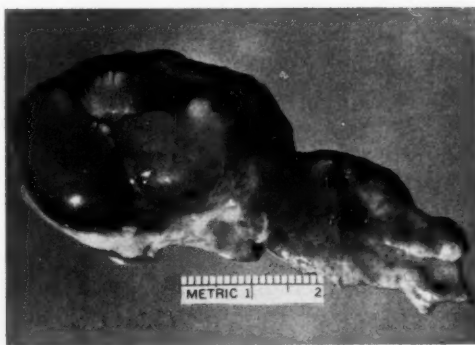


Fig. 3. Specimen removed at surgery.

SUMMARY

A case of cyst of the triangular ligament of the liver is presented, which was best demonstrated by the aid of pneumoperitoneum.

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SUMMARIO IN INTERLINGUA

Cyste del Sinistre Ligamento Triangular del Hepate

Reportos de solmente 7 cystes de ligamentos hepatic poteva esser trovate in le litteratura. Quatro de istos esseva in le ligamento falciforme e 3 in le ligamento terete. Un caso additional es describe in le presente reporto, le prime locate in

le ligamento triangular. Isto esseva demonstrabile le plus clarmente con le adjuta de pneumoperitoneo que revelava que illo esseva separate de stomacho e diaphragma ben que connectite con iste ultime per cordas fibrose.

A Limited Survey of Radiation Exposure from Medical Fluoroscopes¹

ROBERT OWEN GORSON, M.S.,² JESSE LIEBERMAN, M.S.,³ and MARVIN GREEN, B.S.

WITH THE CO-OPERATION of the University of Pennsylvania and dentists and physicians of Philadelphia, the Department of Public Health of the City of Philadelphia instituted in 1956 a study of radiation exposure from medical x-ray units. A survey of dental x-ray units has previously been reported (1). The present paper is concerned with the radiation characteristics of fluoroscopes surveyed in the Philadelphia area and some of the problems involved in controlling unnecessary radiation exposure from their use.

METHOD OF SURVEY

Measurements made on 81 fluoroscopes are included in the present study. Twenty-two units were owned by 8 hospitals⁴ and 4 city clinics, and the remaining 59 were in the offices of physicians engaged in private practice. The distribution of the units according to ownership is presented in Table I. They are listed according to type and manufacturer in Table II. Sixty-seven fluoroscopes were located within the city limits of Philadelphia. The other 14 were in eastern Pennsylvania and southern New Jersey. Twenty of the fluoroscopes, owned by hospitals and radiologists, were inspected at the request of the owners. The others, all in Philadelphia, were chosen at random from a list registered by physicians with the Commonwealth of Pennsylvania Department of Health.

A survey and questionnaire form was used to record systematically four categories of information for each fluoroscope: (a) data from the physician concerning age, manner of use, and average work load;

¹ From the William H. Donner Center for Radiology, University of Pennsylvania, Philadelphia 4, Penna., and the Department of Public Health, Division of Environmental Health, City of Philadelphia, Philadelphia 7, Penna. Presented in part at the Forty-fourth Annual Meeting of the Radiological Society of North America, Chicago, Ill., Nov. 16-21, 1958.

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³ Chief, Occupational Environment Section, Department of Public Health, Philadelphia.

⁴ The Hospital of the University of Pennsylvania was not included in the survey.

TABLE I: OWNERSHIP OF FLUOROSCOPES

Number of Owners	Number of Fluoroscopes
14 general practitioners	14
44 specialists	
31 internists	32
3 pediatricians	3
3 radiologists	3
7 others	7
12 institutions	
8 hospitals	18
4 city clinics	4
TOTALS	81

TABLE II: TYPE AND MANUFACTURER

Manufacturer	Number of Fluoroscopes	
	Vertical	Tilting Table
Continental	10	0
Fischer	1	0
General Electric	3	2
Keleket	2	1
Mattern	15	0
North American Philips	0	1
Peerless	3	0
Pickar	7	10
Profexray	1	0
Siemens	1	0
Standard	7	4
Westinghouse	9	4
TOTALS	59	22

(b) physical inspection; (c) radiation characteristics; (d) radiation exposure to the physician.

MEASUREMENT TECHNIC

The techniques used to measure the radiation characteristics of the fluoroscopes were adapted with modifications for field use from methods developed and described by Hale *et al.* (2). Measurements were made with the field size of the primary

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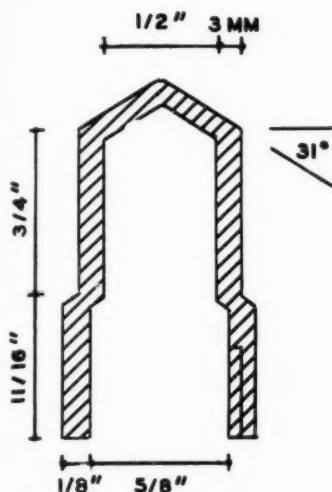


Fig. 1. Cross section through aluminum cap used for inferential h.v.l. determinations. Caps of varying wall thickness were designed to fit Victoreen 25-r condenser ionization chambers; 3 mm. wall thickness, shown here, was found to be most useful. The ratio of chamber reading with cap on to the reading with cap off was calibrated as a function of h.v.l.

x-ray beam adjusted to 10×10 cm. at the panel surface or table top. Tube potential and current settings were those normally used by the physician.

Exposure Dose Rate and Half-Value-Layer Measurements: The "quality" of the radiation was determined by measuring the half-value layer (h.v.l.) in aluminum by an inferential method (2, 3). The design of aluminum caps,⁵ varying in thickness, which were machined to fit over the sensitive volume of the Victoreen 25-r condenser ionization chamber,⁶ is shown in Figure 1. The ratio of the chamber reading with cap on to the reading with cap off was calibrated as a function of the h.v.l. (Fig. 2). The calibration curves were obtained by the method previously described (2). It can be seen in Figure 2 that the h.v.l. calibration curve for aluminum caps is independent of tube potential. Most of the h.v.l. determinations were made with caps 2 mm. and 3 mm. thick; the 3-mm. thickness was found to be most

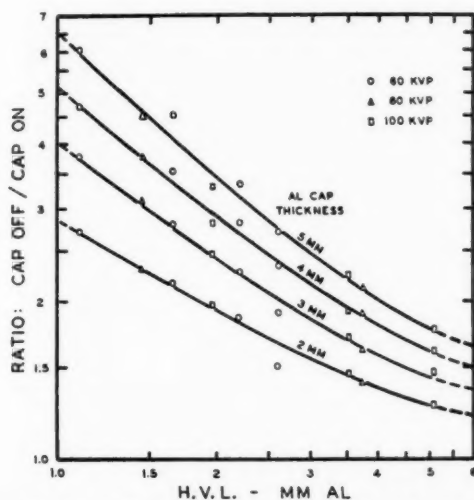


Fig. 2. Calibration of aluminum caps for inferential h.v.l. determinations as a function of cap thickness. Note that calibration is independent of kvp.

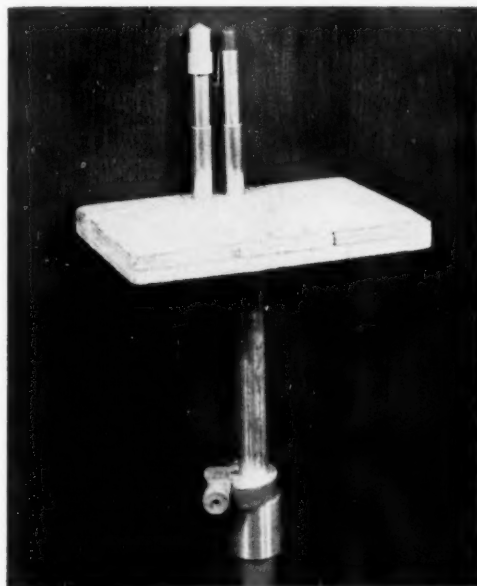


Fig. 3. Victoreen 25-r chambers arranged on adjustable stand to measure the exposure dose rate and h.v.l. of a vertical fluoroscope. One chamber is used for measurement; the other for monitoring fluctuations in exposure dose rate.

satisfactory. A second 25-r chamber was always used as a monitor to avoid uncertainty in measurements due to electrical instability. Readings were taken

⁵ Made of 2S-O aluminum.

⁶ All chambers used in this study were intercompared with a secondary chamber calibrated by the National Bureau of Standards. Appropriate corrections were made for all data.

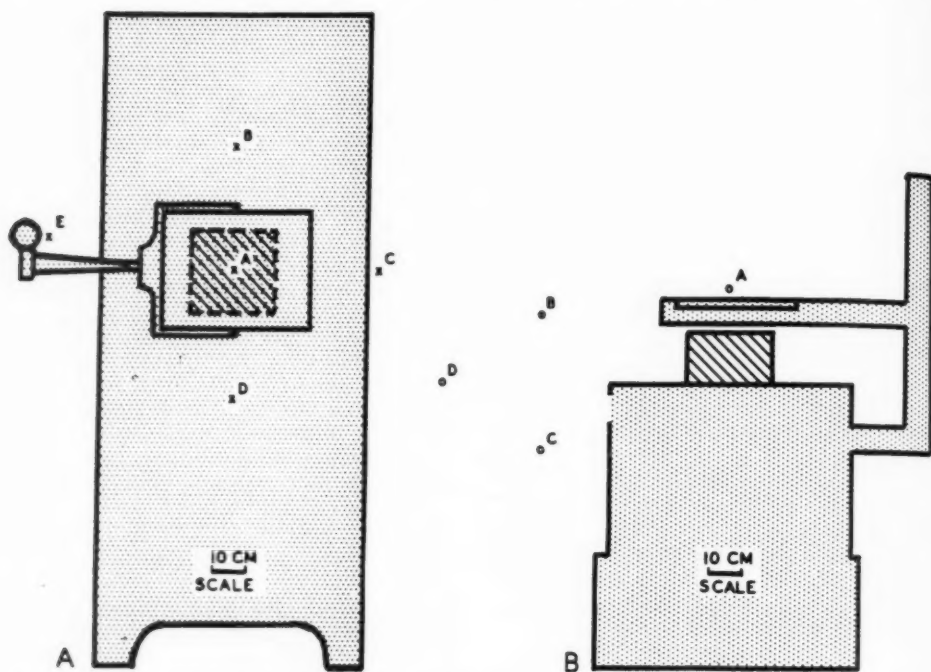


Fig. 4. Location of positions (A, B, C, D, E) for measurement of stray radiation. For vertical fluoroscopes, measurements were made in a plane 20 cm. in front of the screen except for E, at the shutter controls, and for A, at the screen. For horizontal units, measurements were made in a transverse plane through the screen, as shown. Stray radiation index was calculated by doubling reading at A and averaging result with the other readings.

with the chambers positioned in the center of the field in contact with the panel surface. The exposure dose rate at the table top or panel surface was estimated by correcting cap-off readings according to the inverse-square law to the target-panel distance. In Figure 3 are shown the monitor and measurement chambers in position on an adjustable stand for measuring the exposure dose rate and h.v.l. of a vertical fluoroscope.

Stray Radiation Measurements: Measurements of scattered and leakage radiation in the immediate vicinity of the fluoroscopes were made with ionization rate meters⁷ at certain selected locations (Fig. 4). A block of birch wood, 10 inches square and 6 inches thick, was used as a phantom patient. Except for points A and E, the readings taken on vertical fluoroscopes

were made in a vertical plane 20 cm. in front of the fluorescent screen, with the screen in contact with the phantom (Fig. 4, A). The reading at point A was made with the survey meter in contact with the lead-glass cover over the screen. The reading at point E was taken at the shutter controls. Stray radiation measurements for horizontal fluoroscopes were made in a transverse plane through the screen (Fig. 4, B). In both cases, measurements of transmission through the fluorescent screen also were made without the phantom interposed in the beam. When present, protective devices such as lead-rubber flaps and Bucky slot covers were left in place. The phantom in position on an adjustable stand is shown in Figure 5. A reading is being taken at Point E, next to the shutter controls.

In order to compare the stray radiation hazard of various fluoroscopes, it was use-

⁷ The ionization rate meters ("cutie pies") were calibrated with a radium standard.

ful to define a "stray radiation index" (SRI). Since the face of the fluoroscopist is protected only by the lead-glass cover of the screen, the reading obtained at point A (Fig. 4) was considered sufficiently important to be given twice the weight of measurements made at other points. The SRI was calculated by doubling the reading taken at point A and averaging the result with the other readings.

Film-Badge Survey: To study the average exposure received by physicians during fluoroscopy, 53 physicians in private practice were given a pair of commercial film dosimeters. Each was instructed to wear one film badge on the right arm and the other on the left shoulder during fluoroscopy and to keep careful records of the total fluoroscopic time and the number of patients examined during the study period. The badges were usually left with the physician for a period of four to five weeks. The study was repeated for about half of the physicians.

INFORMATION OBTAINED BY INTERVIEW

The data obtained by interviewing physicians are summarized in Tables I and III. Three-quarters of the physicians in private practice were specialists; 30 had been certified by some American Specialty Board. Fifteen of the 18 hospital units were used only by radiologists. The other 3 were used primarily by cardiologists.



Fig. 5. Measurement of stray radiation at shutter controls (point E) with ionization rate meter. Block of birch wood on adjustable stand behind screen is used as a phantom patient.

The data in Table III indicate that radiologists operate fluoroscopes at higher potentials and lower currents than non-radiologists. Three-quarters of the non-radiologists performed only chest fluoroscopy; most of the remainder undertook

TABLE III: SUMMARY OF INFORMATION OBTAINED BY INTERVIEW

Information	No. of Fluoroscopes	Range in Values		Mean Value	Median Value
		Maximum	Minimum		
Age of fluoroscope in years					
Radiologists and hospitals	19	20	3	8.3	8
Nonradiologists	58	28	2	11.6	11
Both groups	77	28	2	10.8	10
Tube potential normally used (kvp)					
Radiologists and hospitals	20	86	50	79	80
Nonradiologists	49	85	35	66	65
Tube current normally used (ma)					
Radiologists and hospitals	20	5	2	3.3	3.0
Nonradiologists	56	12	2	4.7	4.5
Estimated number of examinations per week per machine					
Radiologists and hospitals	21	80	1	28	25
Nonradiologists	60	75	0	8.3	3.9
Estimated average patient exposure time: minutes per machine					
Radiologists and hospitals	19	10	2	3.8	3.0
Nonradiologists	60	5	1/30	1.6	1.0

only limited additional procedures, such as examinations of extremities and occasional foreign-body localization. A large fraction of the fluoroscopic examinations done by radiologists were studies of the gastrointestinal tract and other special procedures. It is not surprising, therefore, that the average estimated exposure time per patient is two to three times greater for radiologists than for nonradiologists. Radiologists also averaged three to four times as many examinations per machine per week as nonradiologists. Many nonradiologists stated that they had greatly curtailed the use of their machines during the last two years.

All of the radiologists and all but 8 of the nonradiologists stated that they wore red goggles for varying lengths of time (one to twenty minutes) before fluoroscopy. All of the radiologists and all but 5 of the nonradiologists said that they wore leaded aprons, and all of the radiologists and all but 14 of the nonradiologists possessed leaded gloves. For 2 of the fluoroscopes owned by nonradiologists and 7 of those in hospitals radiation safety evaluations had been made previously by radiologic physicists.

Six of the 8 hospitals were subscribing to a commercial film-badge service at the time of survey. None of the physicians in private practice monitored personnel radiation exposure. All physicians were asked if they had any idea as to the "radiation output" of their fluoroscopes. Answers were given for one-half the hospital units and, of these, all but one proved to be reasonably accurate. A few physicians in private practice thought that the outputs were "low." A great majority did not know and declined to guess.

PHYSICAL INSPECTION

The data obtained by physical inspection are summarized in Table IV. The National Committee on Radiation Protection and Measurement (NCRPM) (4) recommends that the distance between the x-ray tube focal spot and the front panel or table top of a fluoroscope be at least 18 inches,

TABLE IV: SUMMARY OF OTHER OBSERVATIONS

Observation	Type of Unit Vertical (V) or Tilt-table (H)	Number of Fluoroscopes		
		Yes	No	Unknown
1. Target-to-panel distance at least 18 inches	V H	2 13	57 9	0 0
2. Manually reset cumulative exposure timer	V H	10 13	49 9	0 0
3. Lead-rubber drapes suspended from screen	V H	9 7	50 15	0 0
4. Bucky slot cover or side board	V H	.. 7	.. 15	.. 0
5. Screen and tube ganged together	V H	49 22	10 0	0 0
6. Tube can be energized without screen in position	V H	58 19	1 3	0 0
7. Unilluminated screen margin when shutters fully open	V H	11 2	48 20	0 0
8. Shockproof tube cables	V H	9 14	26 5	24 3
9. Metal tube housing	V H	28 15	10 5	21 4
10. Tube enclosed on all sides	V H	39 15	20 7	0 0

and several State codes (5, 6, 7) require that it be at least 12 inches. About 40 per cent of the horizontal units and 97 per cent of the vertical units had target-to-panel distances measured or estimated to be less than 18 inches. Fifteen per cent of the horizontal fluoroscopes and three-quarters of the vertical units appeared to have target-to-panel distances of 12 inches, or less.

Only 20 per cent of the vertical fluoroscopes and 60 per cent of the tilt-table units were equipped with manually reset cumulative exposure timers (4-7). The range of the timers varied from thirty seconds to sixty minutes. Most were five-minute timers. In two instances, timers failed to terminate the exposure or to give a warning signal at the end of the preset time.

Only 15 per cent of the vertical fluoroscopes had accessory protective shielding around the fluorescent screen. One-third of the tilt-table units were provided with lead-impregnated drapes suspended from the screen and Bucky slot covers or side

TABLE V: SUMMARY OF RADIATION CHARACTERISTICS
(Fifty-nine vertical and twenty-two tilting table or horizontal fluoroscopes)

Observation or Calculation	Range in Values		Mean Value	Median Value
	Maximum	Minimum		
Exposure dose rate in air at panel surface, in r per min.				
Radiologists and hospitals	46.7	1.8	8.9	7.1
Nonradiologists	63.6	2.2	16.3	12.9
Both groups	...	...	14.4	10.0
Half-value layer in millimeters of aluminum				
Radiologists and hospitals	3.7	1.8	2.9	3.1
Nonradiologists	>4.0	<0.5	1.9	1.8
Both groups	...	...	2.1	2.0
Stray radiation index: mr per hour				
Radiologists and hospitals	715	1	139	83
Nonradiologists	372	5	97	75
Both groups	...	...	107	80
Transmission through fluorescent screen shield (no phantom): mr per hour				
Radiologists and hospitals	60	3	18	15
Nonradiologists	120	<2	11	3
Both groups	...	...	12	5

boards, most of which were custom made.

Items 5, 6, and 7 in Table IV represent features preventing the fluoroscopist from accidentally intercepting any part of the primary x-ray beam. The fluorescent screen and x-ray tube were ganged together in all fluoroscopes except 10 vertical units used for orthodiascopy, which requires independent motion of the tube. In all but 4 units (3 tilt-table units with electric interlock switches and 1 vertical unit with screen and tube in fixed positions) it was possible to energize the machine with the screen rotated out of position so that the primary x-ray beam would not be intercepted by it. Item 7 is based on the NBS *Handbook 60* recommendation (6.1.b.) that "the useful beam shall be limited by a cone and an adjustable diaphragm that, when open to its fullest extent, leaves a margin of at least one-quarter inch of unilluminated fluorescent screen regardless of screen position during use" (4). This recommendation has been adopted as a requirement in several State radiation protection codes (5, 7). For the great majority of fluoroscopes examined, a position could be found in which this requirement was not fulfilled, if the regulation were interpreted literally.

For this study, it was necessary to rely on the judgment of the field inspector re-

garding a reasonable range in "screen position during use." A panel-to-screen distance of 35 to 40 cm. was considered the maximum for normal use, except for orthodiascopes, for which the distance is usually fixed at about 50 cm. Only 13 of the 81 fluoroscopes met the unilluminated margin requirement within this range. However, to the extent that the physician exercises reasonable care in limiting the field size and direction of the primary beam, the majority of the other 68 units were not considered unduly hazardous in this respect.

In most cases the amount of added aluminum filter could not be determined without extensive disassembly of the fluoroscope. This was not attempted. It was also impractical to determine whether the tube housing satisfied the definition of "diagnostic tube housing." However, whenever the tube housing could be seen through the available apertures in the side or back panels with the aid of a flashlight, note was made as to whether the tube appeared to be enclosed in a metal tube housing and whether high-tension cables appeared to be insulated. As indicated by items 8 and 9 in Table IV, many fluoroscopes did not have metal tube housings or shockproof cables. About two-thirds of the units were enclosed by panels on all sides.

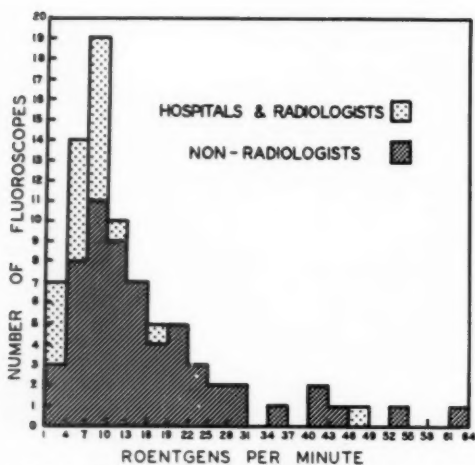


Fig. 6. Distribution of exposure dose rates measured in air at the panel surface with the field size adjusted to 10×10 cm. at the panel and the fluoroscope operated at normal kvp and ma settings.

RADIATION MEASUREMENTS

Exposure Dose Rate: The distribution of the exposure dose-rate measurements made in air at the fluoroscope table top or panel surface is plotted in Figure 6 and summarized in Table V. Half of all the fluoroscopes (14 per cent of those owned by radiologists and hospitals and 63 per cent of those owned by nonradiologists) failed to meet the requirement that the exposure dose rate not exceed 10 r per minute for routine fluoroscopy (4-7).

A comparison of these results with data of Braestrup (8), Sonnenblick (9, 10), and Valaer and Zavon (11) is shown in Table VI. Braestrup's measurements were made on fluoroscopes in New York City hospitals. Sonnenblick's surveys were made on fluoroscopes in New York City and northern New Jersey, and most of the units tested were owned by private practitioners, one-third of whom were pediatricians.

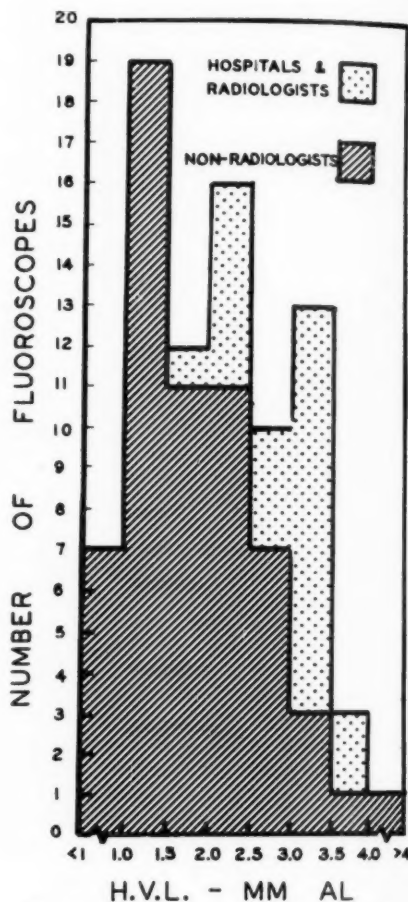


Fig. 7. Distribution of h.v.l. determinations made with field size adjusted to 10×10 cm. at the panel and with fluoroscope operated at normal kvp and ma settings.

Valaer and Zavon limited their study to fluoroscopes used by pediatricians in the Cincinnati area. Their measurements show an average exposure dose rate of about 14 r per minute at the panel surface, in close agreement with the results of this study.

TABLE VI: COMPARISON WITH RESULTS OF OTHER SURVEYS

Author	Date	Number of Fluoroscopes	Range in r/min. at Panel Surface	Percentage of Units Exceeding 10 r/min.
Braestrup (8)	1941	37	7-127	90
Sonnenblick (9, 10)	1951-1954	119	3-118	80
Valaer and Zavon (11)	1957	34	2-38	65
Gorson, et al. (1)	1958	81	2-64	50

Half-Value Layer: The distribution of the radiation "quality" as expressed in terms of measured h.v.l. in millimeters of aluminum is plotted in Figure 7 and summarized in Table V. The results indicate that for fluoroscopes used by nonradiologists the h.v.l. is considerably less than that of machines used by radiologists. A minimum h.v.l. of 2.5 mm. of aluminum under normal operating conditions was considered acceptable (2). About 30 per cent of the fluoroscopes owned by hospitals and radiologists and 80 per cent of the units owned by nonradiologists failed to meet this criterion.

Stray Radiation Measurements: The distribution of the stray radiation index (SRI) measurements is plotted in Figure 8 and summarized in Table V. The higher average SRI for fluoroscopes owned by hospitals and radiologists is undoubtedly due to the higher tube potentials and h.v.l. used by these groups and the fact that all but one of the units were of the tilting type. Stray radiation readings are generally lower for vertical fluoroscopes than for horizontal units without accessory shielding because the measurements are taken behind rather than to the side of the fluorescent screen.

Studies of the scattered radiation patterns around fluoroscopes and analyses of pertinent parameters have been reported by others (12-14). Additional data concerning the relationship between the SRI and the other radiation characteristics for a vertical fluoroscope and a tilting table unit are summarized in Table VII. The SRI

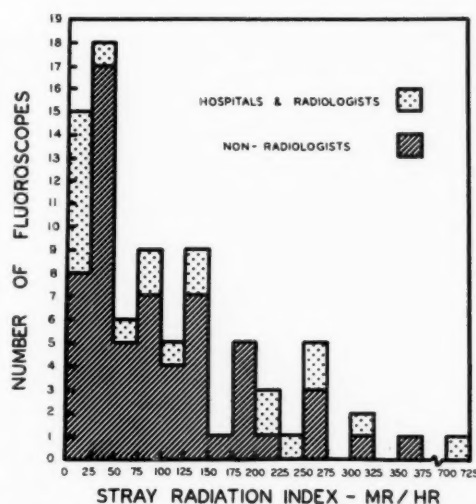


Fig. 8. Distribution of SRI calculations derived from measurements as illustrated in Figs. 4 and 5. Measurements made with field size adjusted to 10 X 10 cm. at panel surface with phantom patient and with fluoroscope operated at normal kvp and ma settings.

measurements were made with all accessory protective shielding removed and the results indicated that the scattered radiation levels increased with kvp or h.v.l. For tilting-table units used in a horizontal position, the SRI can easily be reduced to less than 5 mr per hour (or less than 1 mr per hour per r per minute at the table top) by the use of accessory shielding such as Bucky slot covers, side boards, and lead-rubber flaps suspended from the screen between the patient and the fluoroscopist. The effectiveness of such accessory shielding has been demonstrated by Hale *et al.* (2).

TABLE VII: RELATION BETWEEN STRAY RADIATION INDEX (SRI) AND OTHER RADIATION CHARACTERISTICS

Fluoroscope Operated at 3 ma	Kvp	H.V.L. mm. Al	r/min. in Air at Panel	Lead- Glass Trans- mission, mr/hr.	SRI, mr/hr.	SRI per r/min. Panel
A. Vertical fluoroscope with 10-inch target-to-panel distance. Added filter: 2.7 mm. Al	"Low" (64)	2.3	5.2	<2	66	12.7
	"Med." (73)	2.6	7.5	3	120	16.0
	"High" (85)	3.2	10.0	28	184	18.4
B. Tilting table fluoroscope in horizontal position with 20-inch target-to-table-top distance, open Bucky slot, and no lead-rubber flaps. Dynamax 46. Added filter: 2.0 mm. Al	65	1.8	1.7	<2	15	8.8
	75	2.0	2.7	<2	34	12.6
	85	2.7	4.0	2	62	15.5
	95	3.1	5.3	10	115	21.7

TABLE VIII: SUMMARY OF FILM-BADGE AND WORK-LOAD STUDY
(Twenty-six fluoroscopes used by nonradiologists in private practice)

Observation or Calculation	Range in Values		Mean Value	Median Value
	Maximum	Minimum		
Period of study (weeks)	17	4	7.8	7
Work load:				
Patient examinations per machine per week	30	0.2	3.8	3.5
Minutes of fluoroscopy per machine per week	75	0.3	6.5	2.7
Average patient exposure per machine (minutes)	3.2	0.1	1.7	1.1
Physician film-badge study				
Mr per minute of fluoroscopy				
Right arm	11	<0.1	1.5	0.5
Left shoulder	7.5	<0.1	1.1	0.5
Mr per week				
Right arm	80	<0.1	4.8	1.2
Left shoulder	16.5	<0.1	2.2	1.0

Screen Transmission Measurements:

The results of exposure dose rate measurements made above the screen are summarized in Table V. The readings were taken with mobile screens set 6 inches from the panel, with normal ma and kvp settings, and without the phantom in the beam. Similar measurements for two control units are listed in Table VII. Readings of less than 20 mr per hour under normal operating conditions were considered acceptable (2). Seventeen per cent of the fluoroscopes (9 vertical units and 5 tilting-table units) failed to meet this criterion.

Film-Badge Survey and Work-Load Study: Machine work load and personnel exposure data sufficient for analysis were obtained from 27 of 53 physicians in private practice. The results are summarized in Table VIII. An average of about four patient examinations were performed per machine per week during the study period, or about half the average number estimated by the nonradiologists during interviews (Table III). The average recorded patient-exposure time of about two minutes generally agrees with the average estimated value obtained by interview. A majority of the units were operated for less than three minutes a week. Valaer and Zavon obtained similar results in a time-of-use study on 29 fluoroscopes used by pediatricians (11). The film-badge readings generally were very low, with an average value of about 5 mr per week for the right arm and 2 mr per week for the left shoulder. These findings are consistent with the average SRI of about 1.6 mr per minute.

DISCUSSION

The primary objectives of this study were to obtain new data regarding the potential hazard of fluoroscopes, to test certain radiation measurement technics for field use, and to determine the extent to which fluoroscopes meet the requirements of radiation protection codes and recommendations of the NCRPM. For discussion of the results and some of the difficulties encountered, two aspects of the study should be considered separately. The first concerns the construction and radiation characteristics of the fluoroscope; the second pertains to the manner of its use.

A. Radiation Characteristics: The potential radiation hazard of a fluoroscope is a function of its inherent radiation characteristics, and these, in turn, depend upon machine design. Hence the safety of a fluoroscope may be judged either by its radiation characteristics or by its design and construction. In practice, however, it is difficult to check some of the NCRPM recommendations or requirements of State codes as to design. Thus, the authors found it impractical to measure total filtration, type of tube housing, maximum field size, lead equivalence of barriers, and any specifications dependent upon maximum continuous kvp and ma ratings. Fortunately, many fluoroscopes which do not meet certain specifications are not necessarily hazardous. In the authors' experience, however, it is both necessary and sufficient to demonstrate that fluoroscopes meet reasonable performance standards.

In this study, the authors have found that the following measurement criteria, consistent with performance recommendations of NBS *Handbook 60*, are practical for field evaluation of fluoroscopes and are sufficient to assure a reasonable degree of inherent radiation safety.

As measured under normal operating conditions and with the field size adjusted to 10×10 cm. at the panel surface:

(a) The h.v.l. in aluminum of the useful beam should be at least 2.5 mm.

(b) The exposure dose rate at the panel or table-top surface should not exceed 10 r per minute.

(c) The exposure dose rate above the fluorescent screen should not exceed 20 mr per hour (without patient or phantom and with the screen at a distance of 15 cm. from the panel surface if it is not in a fixed position).

(d) The SRI should not exceed 50 mr per hour as measured with a specified phantom patient such as the one used in this survey.

(e) No part of the primary beam should extend beyond the limits of the primary x-ray barrier with the beam centered on the fluorescent screen and with the screen at a distance of 35 cm. from the panel surface, unless the distance is otherwise fixed.

Twenty-five per cent of the fluoroscopes (14 hospital units and 6 owned by non-radiologists) met the first two performance standards. Of these, only 10 (7 hospital units and 3 owned by nonradiologists) also met the next two standards. At the beginning of the survey, an attempt was made to apply the requirement for unilluminated screen margin. As discussed above, this criterion is now thought to be less useful than the recommended performance standard (e). Accordingly, the number of fluoroscopes in the survey that would have met all of the recommended performance criteria is not precisely known but is probably not more than a half dozen. Nevertheless, about 50 per cent of the fluoroscopes in the survey were considered not unduly hazardous, and it is estimated that at least 90 per cent can

easily be made acceptable by one or more of the following modifications: (a) the addition of aluminum filtration; (b) decreasing the maximum possible ma setting; (c) decreasing the maximum range in shutter opening; (d) adding accessory protective shielding. In a few machines it may also be necessary to increase the distance between the panel and the x-ray tube and to replace old fluorescent screens.

If design specifications that could be checked are also used to judge the fluoroscopes in this survey, then only 2 (hospital) units were acceptable by the maximum recommendations of NBS *Handbook 60*.

The authors feel that unnecessary confusion could be avoided if radiation safety codes were to make clear distinction between design requirements and performance standards. Design specifications are of value for the manufacturer of new equipment but are of limited use in the field testing of fluoroscopes. Minimum performance standards, however, can be applied in the safety evaluation of all fluoroscopes regardless of original design. It would seem desirable, therefore, for State codes containing detailed regulations to limit design specifications to medical and dental x-ray equipment manufactured, sold, or resold after a suitable future date and to require that fluoroscopes in present use be modified only to the extent necessary to meet minimum performance standards. These requirements should be consistent with recommendations of the NCRPM and should be uniform among the States to avoid unnecessary costs to the manufacturer.

B. Manner of Use: In radiography the patient exposure is limited, to a large extent, by the acceptable density of the roentgenogram. Faulty radiographic technics are generally easy to spot and correct. There is no technical restriction, however, to limit excessive patient exposure from poor fluoroscopic technic. The manner in which a fluoroscope is used depends upon the prudence, skill, and training of the physician and involves numerous variables, many of which are

difficult to assess. Some of the factors which are important in limiting radiation exposure to both patient and physician are summarized as follows:

1. *Dark Adaptation:* The importance of becoming thoroughly dark-adapted before commencing a fluoroscopic examination has been documented in detail in the excellent studies by Chamberlain and Henny (15). Although most physicians in this study indicated that they do take time to dark-adapt, many admittedly spend much less than ten minutes, the minimum recommended time (16).

2. *Time:* It is important to keep the x-ray beam on only as long as necessary and to reserve fluoroscopy largely for observation of the dynamics of motion (16). Many of the private practitioners interviewed in this study said that they are now doing much less fluoroscopy than they were several years ago, indicating a reduction in the use of their machines for survey and screening purposes.

3. *Field Size:* Keeping the primary beam size to a minimum consistent with the requirements of the examination is of importance not only for minimizing the integral dose to the patient, but for limiting the amount of radiation scattered to other parts of the body, to the physician, and to the fluorescent screen.

4. *Tube Current and Operating Potential:* The results of this survey indicate that many physicians in private practice tend to fluoroscope with low kvp and high ma settings. A number of authors have demonstrated that to reduce patient exposure, it is best to use *high kvp* (i.e., high h.v.l.) and *low ma* settings (12, 13).

5. *Accessory Shielding:* There are still a number of physicians who disregard the wearing of leaded aprons and gloves and the use of other protective accessories because they have observed no personal ill effects from the omission of these precautions. The present study is encouraging, however, in that the great majority of the physicians interviewed at least had protective aprons and gloves and most claimed to use them.

On the basis of this study, the authors would agree with Powell (17) and other authorities that technics of fluoroscopy and manner of use of the apparatus are not accessible to control by regulatory legislation and inspection. Improvement in standards of fluoroscopic practice, which requires the physician's active co-operation, founded on education and understanding, will continue to evolve primarily through the educational efforts of medical groups and institutions (17-22).

SUMMARY

1. The results of a survey of radiation characteristics and manner of use of 81 fluoroscopes owned by hospitals and private practitioners are analyzed. Survey technics consisted of interviews with the physician, physical inspection of the fluoroscope, and radiation measurements.

2. Measurement technics and methods of survey are described. Practical difficulties in applying some requirements of radiation protection codes are discussed. It is suggested that distinction be made in regulatory codes between design specifications and performance standards, with the former applying to the manufacture and sale of fluoroscopes and the latter applying to fluoroscopes in use.

3. A set of radiation performance standards, derived from and consistent with recommendations of the NCRPM, are proposed as practical guides for field evaluation of the radiation safety of fluoroscopes.

4. Only 2 fluoroscopes met all the design and performance recommendations of NBS *Handbook 60* and it is probable that none would have satisfied all of the requirements of some radiation protection codes.

5. About 7 per cent of the fluoroscopes were judged satisfactory by the proposed performance standards. However, almost half of the units produced an exposure dose rate of less than 10 r per minute at the panel surface, under normal conditions of use, and were not considered unduly hazardous.

6. Fluoroscopes used by hospitals and radiologists produced, on the average, radiation at lower exposure levels (8.9 r per minute) and higher h.v.l. (2.9 mm. of Al) than those used by nonradiologists (16.3 r per minute and 1.9 mm. of Al).

7. Fluoroscopes owned by hospitals and radiologists were operated, on the average, at lower ma (3.3) settings and higher kvp (79) settings than those used by nonradiologists (4.7 ma and 66 kvp).

8. Although many fluoroscopes produced unnecessary amounts of stray radiation, the average exposure of physicians in private practice appeared to be very low (5 mr per week to the right arm and 2 mr per week for the left shoulder) due to the low average work load (6.5 minutes per week).

9. Interviews with nonradiologists indicate that most of them limit fluoroscopic examinations to the chest, and many have recently curtailed the use of fluoroscopy.

10. It is estimated that over 90 per cent of the fluoroscopes could be made acceptable by one or more of the following modifications: adding more aluminum filtration, decreasing maximum ma setting, decreasing maximum shutter opening, and adding accessory shielding.

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SUMMARIO IN INTERLINGUA

Un Enquete, de Compasso Restrignite, del Exposition Radiational ab Fluoroscopios Medical

Es analysate le resultatos de un enquete del characteristics de radiation e del modo de empleo de 22 fluoroscopios in

9 hospitales e 4 clinicas municipal e de 59 fluoroscopios in le possession de medicos private. Le technica usate in le enquete

includeva interviews con le medicos, le examine physic del apparatus, e mesurationes de radiation.

Es discutite le difficultates del application de certes del requirimentos in le codices de protection contra le radiation. Solmente 2 del fluoroscopios satisfaceva omne le recommendationes de construction e manipulation continite in le Manual 60 del Bureau National de Standards, e il es probable que nulle del fluoroscopios haberea satisfacite omne le requirimentos de certe altere codices de protection contra le radiation. Tamen, 7 pro cento del fluoroscopios investigate esseva considerate como satisfactori secundo le proponite standards de fonctionnement que ha essite derivate ab le recommendationes del Committee National pro le Protection Contra le Radiation. Es suggerite que un distinction debe esser facite in le codices regulatori inter iste standards e le specificationes de construction que es applicabile al fabrication e al vendita del machinas.

A generalmente parlar, le fluoroscopios in le possession de hospitales e de specialistas de radiologia esseva usate a plus basse nivellos de milliampere (3,3) e a plus alte nivellos de kvp (79) que le fluoroscopios in le possession de medicos non-specialista de radiologia (4,7 ma e 66 kvp).

Le prime de iste gruppos de fluoroscopios produceva, al media, radiation a plus basse nivellos de exposition (8,9 r per minuta) e con plus alte spissitates de medie valor (2,9 mm de Al) que le secunde (16,3 r per minuta e 1,9 mm de Al).

Ben que multes del fluoroscopios produceva quantitates innecessariamente alte de radiation disperse, le exposition medie del medicos de practica private pareva esser multo basse (5 mr per septimana al bracio dextere e 2 mr per septimana al spatula sinistre). Le explication de isto es le infrequente empleo del apparatus.

Es estimate que plus que 90 pro cento del fluoroscopios studiate poterea esser rendite acceptable per un o plures del sequente modificationes: Augmentar le filtration de aluminio; reducir le maximo del milliamperage; reducir le apertura maximal del obturator; e adder al armatura accessori.

Le autores opina que le technicas fluoroscopic e le modo de lor uso non pote esser regulate per le medios de legislation e inspection. Le melioration del standards de practica fluoroscopic require le cooperation active del medico. Illo resulta de education e comprehension e va continuar evolver se primariamente per le effortios de gruppos e institutiones medical.



Design of Free-Air Ionization Chambers for the Soft X-Ray Region (20-100 kv)¹

VICTOR H. RITZ, B.S.

THE ROENTGEN HAS been recommended (1) by the International Commission on Radiological Units and Measurements as the unit of exposure dose. A measurement with a free-air ionization chamber is the most convenient way of accurately determining exposure dose in the soft x-ray region. Design criteria for standard free-air chambers have been summarized by Wy-

was undertaken to provide design criteria for 20 to 100-kv radiation with filtration ranging from 2 mm. of beryllium to 2 mm. of beryllium plus 4 mm. of aluminum.

A typical free-air ionization chamber is shown schematically in Figure 1. The roentgen is defined in terms of the ionization produced by the interaction of the x-ray beam with a specified mass of air (1).

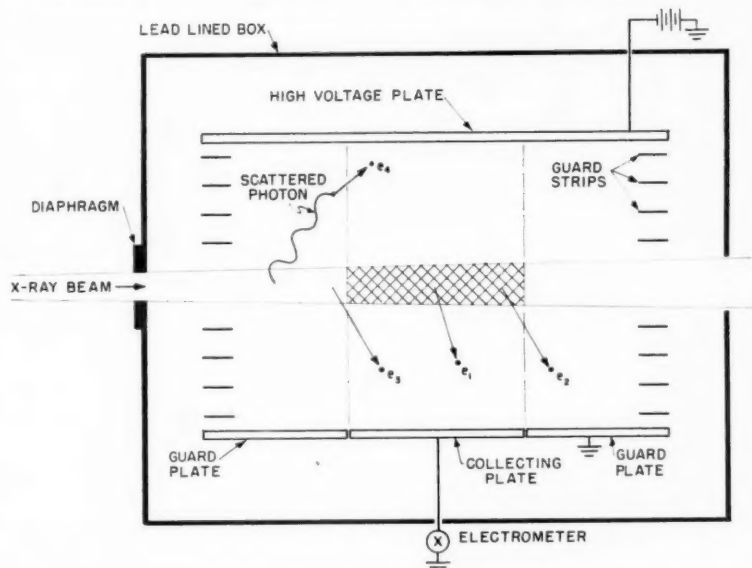


Fig. 1. Schematic top view of a typical free-air ionization chamber.

ckoff and Attix (2) in National Bureau of Standards *Handbook 64* for moderately and heavily filtered x-rays generated at potentials from 50 to 500 kvcp. Agreement to about 0.5 per cent has been reached in international intercomparisons of the roentgen in this energy region. In intercomparisons involving lightly filtered low-energy x-rays, however, differences of 1 per cent or more have been observed (3, 4). The present experiment

In practice, however, one defines a volume represented in Figure 1 by the cross hatched region. The cross-sectional area of the volume is determined by the diaphragm, and the length of the collecting region by the length of the collector and by the electric field between the high-voltage and collecting plates. The presence of the grounded lead box tends to distort the electric field in the collecting region, but guard plates and guard strips can be used

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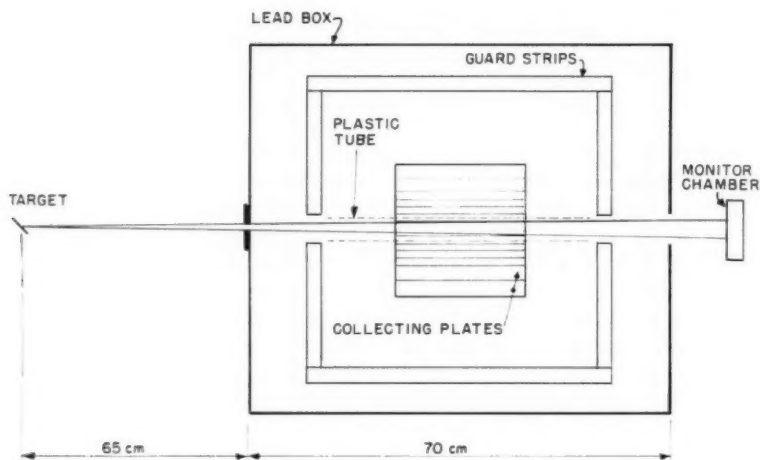


Fig. 2. Side elevation of the experimental set-up.

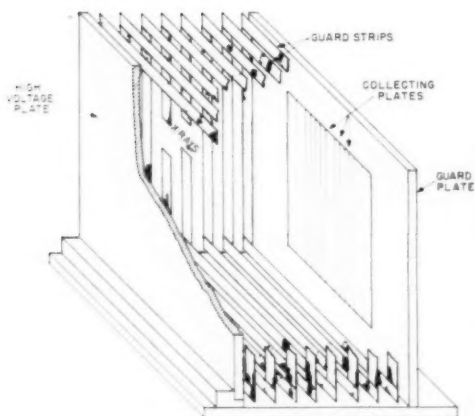


Fig. 3. View of experimental free-air chamber with collectors in position for the field distortion study.

to eliminate such distortion. The guard strips are uniformly spaced between the ground and high-voltage plates and are parallel to them. The potentials of the strips are fixed by a resistor network to give a linear potential gradient between the plates. Distortion can also be caused by the guard strips themselves. This effect becomes important when the strips are close to the edge of the collector or when the centerline-to-centerline spacing between adjacent strips is large.

The x-ray beam interacts with the air to produce electrons like e_1 , which produce

ionization in the collecting region. The precise determination of the roentgen requires that such electrons expend their energy in the air before striking the high-voltage or collecting plates. Thus the proper design of a free-air chamber requires a knowledge of the range of these primary electrons. Electrons like e_2 cause ionization outside the collecting region, but under conditions of electronic equilibrium this loss is compensated by electrons like e_3 . Conditions may also exist in which a photon is scattered out of the primary beam and interacts to produce an electron like e_4 . This represents a contribution that is not included in the definition of the roentgen. This scattered photon contribution must be determined and subtracted from the total ionization measured by the chamber.

Another correction to be applied to a free-air chamber is for the attenuation of the x-ray beam by the air between the diaphragm and the center of the collector. This correction becomes quite large in the soft x-ray region and is, in fact, the largest single correction to be applied to the free-air chamber. The air attenuation correction can be reduced by decreasing the length of the air path between the diaphragm and collector. This, however, increases the distortion caused by the guard-strip system. In practice the reduction

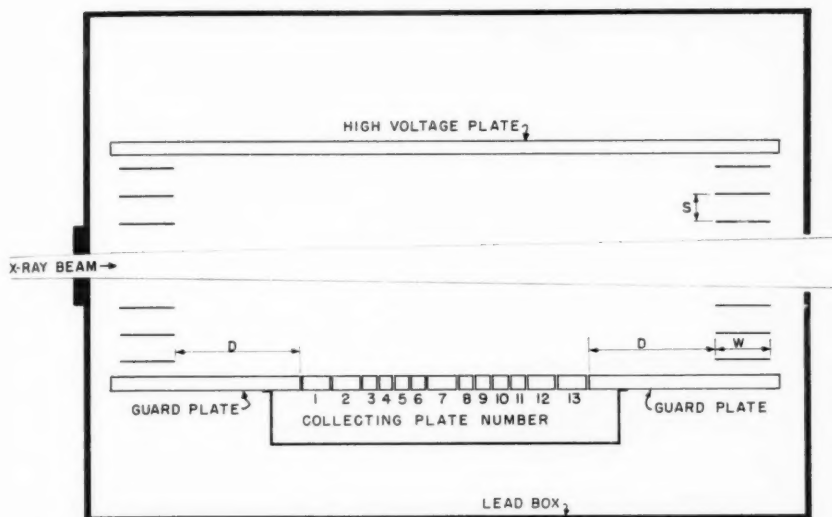


Fig. 4. Section through the chamber, viewed from above, as used in the field-distortion study. The collecting strips number 1, 2, 7, 12, and 13 were 0.5 in. wide, the remaining strips were 0.25 in. wide. D is the distance from the edge of the collecting plate assembly to the guard strip system; S is the centerline-to-centerline spacing of the guard strips. W is the depth of the guard strips.

in the length of air path is limited by the field distortion.

This paper will discuss: (a) the distortion of the electric field in the collecting region by the guard-strip system, (b) the range of primary electrons like e_1 and the scattered photon contribution, and (c) other corrections, such as air attenuation, which are particularly important in the soft x-ray region.

APPARATUS

A side elevation view of the experimental arrangement is shown in Figure 2. A tungsten-target x-ray tube with a beryllium window 2 mm. thick was operated at exciting potentials of 20 to 100 kvcp. The kilovoltage was monitored manually throughout the experiment, and errors because of fluctuations in output were avoided by the use of a monitor chamber placed behind the experimental chamber.

The experimental free-air chamber is shown in Figures 2-4. The thirteen aluminum collecting plates were insulated from each other by narrow air gaps (0.125 to 0.25 mm. wide) and from ground by a polyethylene insulator. They could be grounded or connected to the charge-

measuring system by means of low-noise coaxial cables that passed through the lead box to a terminal box. The collecting plate assembly was machined as a unit until it was flat, to about 0.0025 mm., to avoid field-distortion effects due to the collectors themselves (2). A thin coat of colloidal graphite was put on the collectors to eliminate contact potentials (2). The collecting plates could be turned so that their long axes were vertical for the field-distortion study (Figs. 3 and 4) or horizontal for the electron-range and photon-contribution studies (Fig. 2). Vibrating reed electrometers were used as null detectors (2) to measure the ionization currents in the experimental chamber and monitor.

The guard-strip system shown in Figures 3 and 4 consisted of brass strips separated by Bakelite spacers, surfaces of which were made conducting with colloidal graphite and then scribed with a fine line to insulate adjacent guard strips. This minimized the amount of exposed insulator that could be seen by the collecting plates and eliminated distortion of the electric field by the insulators. The horizontal guard strips were kept fixed in position. The vertical guard strips were movable so that the dis-

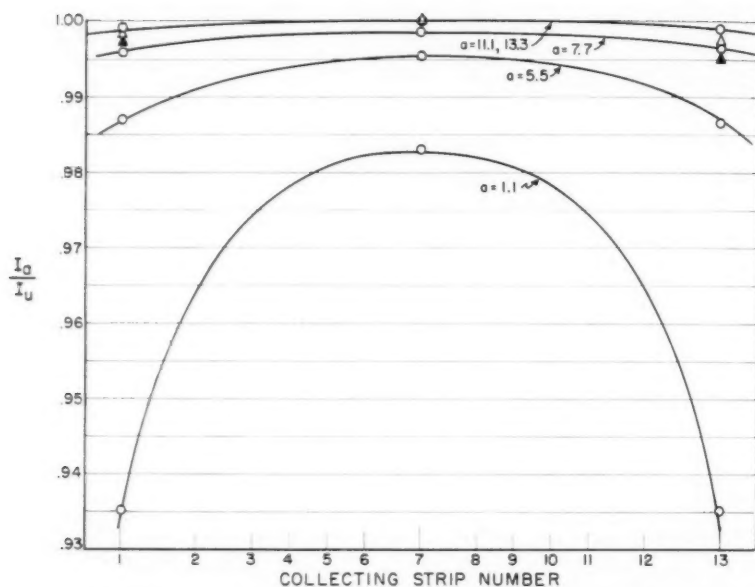


Fig. 5. Field distortion across a collecting plate 11.8 cm. wide. I_a is the ionization measured for a particular value of $a = D/S$. I_u is the ionization measured when the field is undistorted. \circ data of this experiment at 50 kv with inherent filtration and 100 kv with 4 mm. aluminum filtration. \blacktriangle data of Roth (7) at 50 kv, 0.24 mm. Al h.v.l. \triangle data of Roth at 200 kv, 0.56 mm. Cu h.v.l.

tance between them and the collecting plates could be varied to investigate field distortion.

The ionization distribution of the scattered photon contribution was obtained with the aid of a polystyrene tube, 2 cm. inside diameter, 0.22 mm. thick. This wall thickness was greater than the maximum electron range so that ionization from electrons generated by the primary x-rays could not be produced outside of the tube. The tube was made conducting with a coating of colloidal graphite. Scribed lines through the graphite along the length of the tube insulated portions of it from each other and permitted them to be electrically connected to the guard strips so as to reduce the field distortion caused by the tube itself (8).

FIELD DISTORTION

A section through the experimental free-air chamber, viewed from above, is shown in Figure 4. The thirteen collecting plates

were used to study the ionization at different points along the x-ray beam. The change in ionization for different guard-strip configurations was a measure of the change of field distortion caused by the guard strips. The method used was similar to that described earlier by Failla (5). In general, field distortion can be caused by the grounded lead box and by the guard strips themselves. The guard-strip system used in this experiment completely shielded the collecting region from the box. No change in the ionization current was measurable when the potential of the box was changed from ground to that of the high-voltage plate. The distortion studied was thus due only to the guard strips themselves. Two sets of guard strips were used: one with S , the centerline-to-centerline spacing of the strips, equal to 0.9 cm. and a strip thickness of 0.16 cm.; the other with S equal to 0.45 cm. and a strip thickness of 0.08 cm. The distance between the guard strips and the collecting or high-voltage

plates was $S/2$ for the strips closest to the plates. The potential across these strips was half that applied to the strips with spacing S . W was kept fixed at 1.6 cm. D , the distance between the edge of the collector and the guard strips, was varied from 1 to 12 cm. The distance between the high-voltage and collecting plates was 12.5 cm. There were 10-cm.-wide guard plates above and below the collectors and 14-cm.-wide guard plates at the front and back of the chamber.

Figure 5 shows the results of the field distortion study. The distortion was found to depend on $a = D/S$. I_a is the ionization measured for a particular value of a . I_u , the ionization measured when the field is undistorted, was determined by removing the guard-strip assembly and averaging the ionization measured with the lead box at ground potential and at the potential of the high-voltage plate. The average corresponds to a measurement made with a field undistorted by the box (2). A ratio of I_a/I_u equal to 1 in Figure 5 indicates an undistorted field. This ratio is plotted as a function of the collecting strip number.

Since the total width of collecting strips 1 to 13 was 11.8 cm., Figure 5 represents the field distortion at different points across an 11.8-cm.-wide collector. This figure can be used to average the distortion and obtain ratios of I_a/I_u across an 11.8-cm. collector of 0.966, 0.992, 0.998, and 1.00 for values of a equal to 1.1, 5.5, 7.7, and 11.1 (or greater) respectively. The distortion across collecting plate assemblies that are not 11.8 cm. wide cannot be estimated from Figure 5. A collecting plate assembly consisting of several collectors whose combined width was 11.8 cm. could be designed. A narrow collector at the front of the assembly could be used to measure the low-energy, inherent-filtration x-rays, while the wider collectors could measure the high-energy, heavily filtered x-rays. Figure 5 can be used to estimate the distortion for narrow collecting strips if their width is approximately the same as those used in this experiment. For exam-

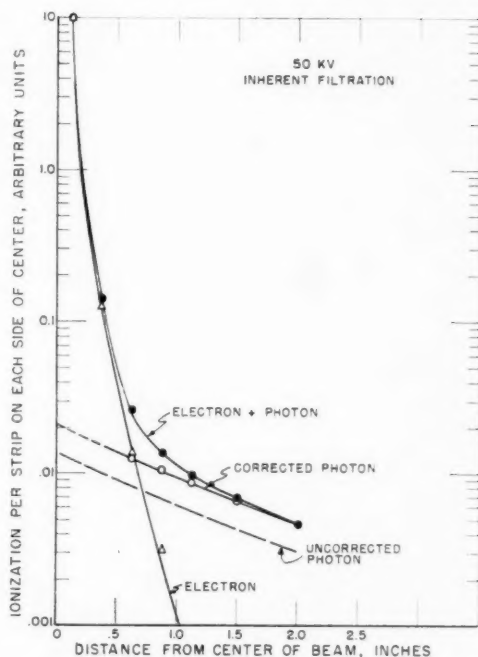


Fig. 6. Method of determining primary electron and photon contributions. ● Electron + photon contribution (tube out). ○ Photon contribution (tube in). △ Primary electron contribution (by subtraction).

ple, a 1.3-cm.-wide collector at the end of the collecting plate assembly would have ratios of I_a/I_u equal to 0.999 and 0.996 for a equal to 11.1 and 7.7.

Data supplied by Roth (6) for a similar experiment, in which a equalled 11, are also shown in Figure 5. Roth found that the field distortion depended upon the energy of the x-ray beam used in the experiment. This effect may have been due to distortion caused by the exit hole for the beam that was cut in the guard-strip system. One would expect exit-hole distortion to be smaller at higher energies since a smaller fraction of the total ionization takes place near the center of the beam. Roth's data at 200 kv are in good agreement with the present experiment, which was done at 50 kv with inherent filtration, and at 100 kv with 4-mm. aluminum filtration. No energy dependence of field distortion was found in this experi-

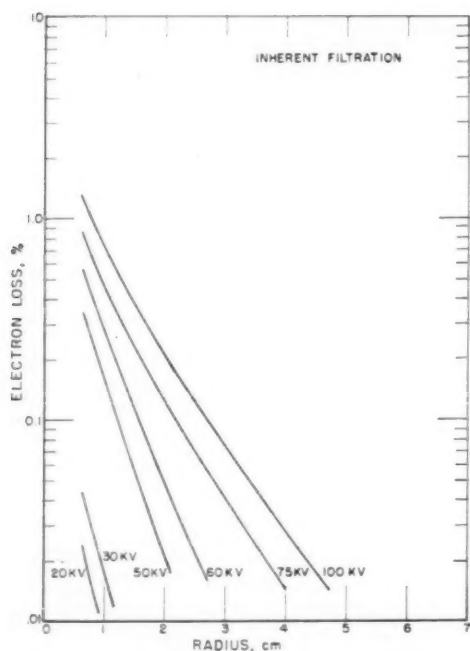


Fig. 7. Loss of electron-produced ionization (in percentage of total electron ionization) beyond different radii from a zero-diameter beam of constant potential x-rays. The filtration was 2 mm. of beryllium (inherent) + 1 meter of air.

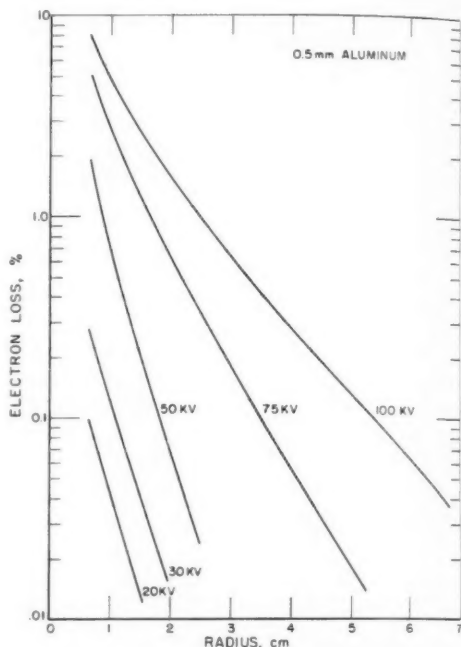


Fig. 8. Loss of electron-produced ionization (in percentage of total electron ionization) beyond different radii from a zero-diameter beam of constant potential x-rays. The total filtration was the inherent filtration + 0.5 mm. aluminum added filter + 1 meter of air.

ment, indicating that the exit hole (1.8 cm. square) in the guard-strip system had no effect upon the distortion. This indicates that fairly large holes may be cut in the guard strips without serious distortion. In general, however, the size of the entrance and exit holes should be minimized, though they must be large enough to permit the x-ray beam to pass through the guard strips without striking them.

The primary objective of the field-distortion study was to devise a guard-strip system that minimized the distance from the diaphragm to the collector and caused negligible (<0.1 per cent) field distortion. No attempt was made to vary the height of the vertical guard strips because the chamber could be oversized in the vertical direction without a prohibitive increase in weight. A qualitative discussion of the effect of varying the height of the chamber can be given. The distortion increases

most rapidly at the top and bottom of the collector as the height of the vertical guard strips is decreased. The effect of this distortion on the total ionization measured by the chamber is decreased by the fact that the ionization density is usually small at the top and bottom of the collector. The horizontal guard strips at the top and bottom of the chamber may also interact to change the field distortion caused by the vertical guard strips, but this type of distortion should be slight (2). The heights of Roth's vertical guard strips and those in the present study were 35 and 28.5 cm., respectively. The close agreement between the two experiments indicates that the field distortion is relatively insensitive to changes in the height of the free-air chamber if the height is large. The field distortion might also depend upon the thickness of the guard strips. A check was

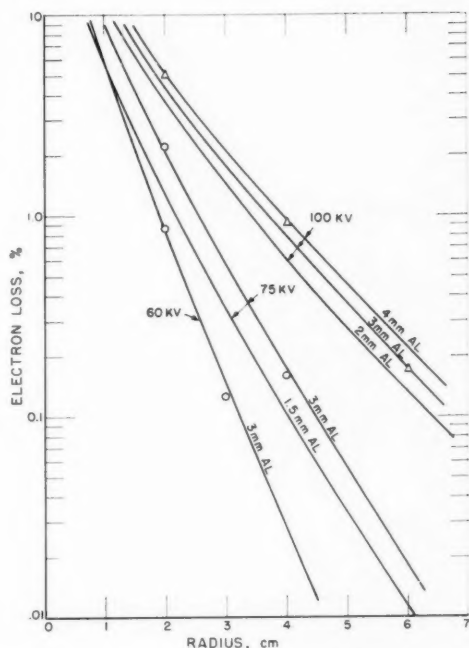
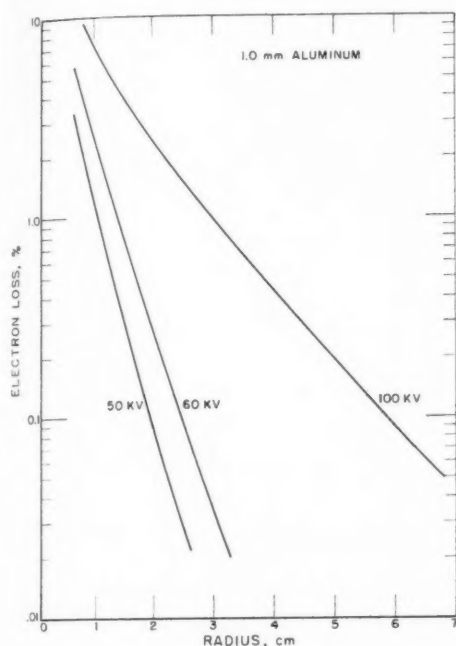


Fig. 9. Loss of electron-produced ionization (in percentage of total electron ionization) beyond different radii from a zero-diameter beam of constant potential x-rays. The total filtration was the inherent filtration + 1.0 mm. aluminum added filter + 1 meter of air.

Fig. 10. Loss of electron-produced ionization (in percentage of total electron ionization) beyond different radii from a zero-diameter beam of constant potential X-rays. \circ Data of Attix and DeLaVergne at 60 kv, 3 mm. Al filtration and 75 kv, 3 mm. Al filtration. \triangle Data of Attix and DeLaVergne at 100 kv, 4 mm. Al filtration.

made with $S = 0.9$ cm. and $D = 5$ cm. by varying the thickness of the strips from 0.16 cm. to 0.9 cm.² No change in the field distortion was observed.

Gross distortions of the electric field can occur if exposed insulators are present in the free-air chamber. In one instance the ionization changed by 25 per cent when an exposed insulator was removed. The exposed insulator surface was minimized in the present experiment and the effect of the insulators separating the guard strips was checked by placing a dummy insulator in the chamber. Small distortions of the

field can occur if the resistors in the voltage-dividing network for the guard strips are not matched properly. Measurements indicate, however, that this effect is negligible if the resistors are matched to ± 5 per cent.

The data taken in the course of the field-distortion study yielded information about the uncertainty in determining the collecting volume of the free-air chamber. The ionization per length of collector was measured under conditions of negligible field distortion from the guard strips and corrected for air attenuation. If the collecting volume was undistorted and if the length of the strip has been measured with sufficient accuracy, each strip should then measure the same ionization/length. Actually, the ionization/length determined experimentally for each strip was found to be within ± 0.2 per cent of the average. Thus the maximum uncertainty in the collecting volume due to field distortion

² A new low-energy (20–100 kv) free-air chamber with guard strips 14 cm. high has been intercompared with the NBS medium-energy (60–250 kv) standard which has guard strips of 27 cm. height. The agreement between the two systems (different capacitors, diaphragms, potentiometers, etc.) was well within the ± 0.5 per cent expected for such an intercomparison (2). This indicates that no gross distortions of the electric field occur when the guard-strip height is reduced to 14 cm. A description of the new low-energy standard and a discussion of the intercomparison will be published shortly.

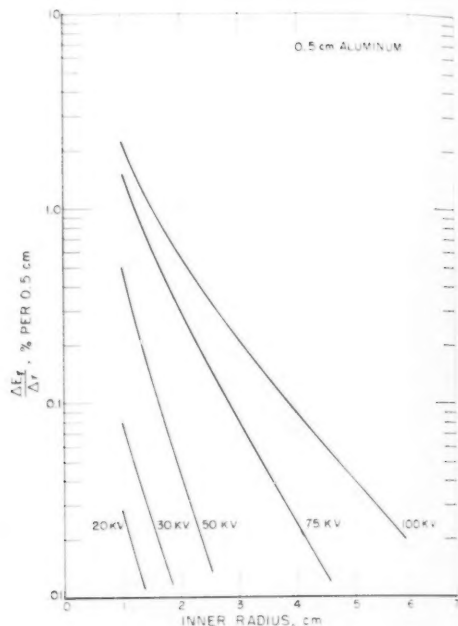
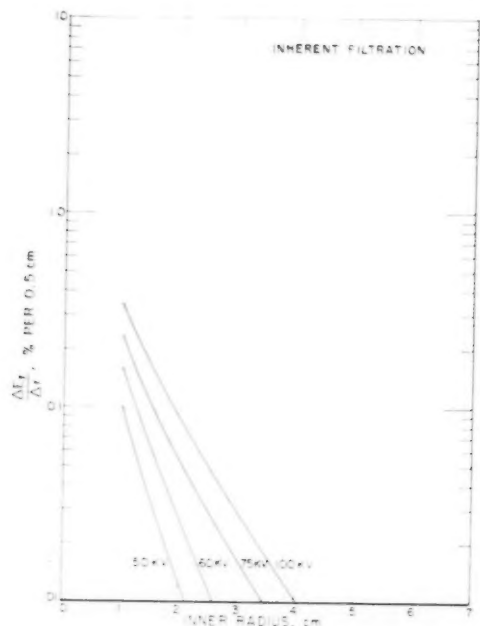


Fig. 11. Loss of electron-produced ionization per 0.5 cm. radius increment for the x-rays of Fig. 7.
Fig. 12. Loss of electron-produced ionization per 0.5 cm. radius increment for the x-rays of Fig. 8.

caused by the collectors themselves and to difficulties in measuring the length of the collector (6 mm. in this experiment) is about ± 0.2 per cent.

To summarize, certain points are to be borne in mind in the design of a free-air chamber with minimal field distortion. Distortion caused by the lead box can be estimated from *Handbook 64*, while Figure 5 can be used to determine the distortion caused by the guard-strip system. This distortion will be independent of the thickness of the guard strips and relatively insensitive to changes in the height of the guard strips. Distortion caused by lack of planarity of the collector and its guards will be negligible if the collector and guards are machined flat, to about 0.0025 mm. per centimeter of collecting plate width (2). The size of the entrance and exit holes cut in the guard-strip system for the x-ray beam should be as small as possible. The amount of exposed insulating material in the chamber must be minimized, and the effect of any remaining exposed insulator should be determined.

ELECTRON AND SCATTERED PHOTON CORRECTIONS

Figure 2 shows a side view of the arrangement used to determine the electron distributions and the scattered photon contributions. The experimental procedure was similar to that used by previous workers (7, 8). The collecting plates were turned so that their long axes were parallel to the x-ray beam. The ionization was first sampled by the different collectors, with the plastic tube in the chamber. The tube was aligned coaxially with the beam. The ionization measured with the tube in place was due only to the scattered photons. The tube was then removed. The ionization measured under the second condition was the sum of the primary electron and scattered photon contributions. The primary electron distribution could then be determined by subtracting the photon contribution measured previously. A typical example is shown in Figure 6. The photon curve was corrected for attenuation in the walls of the tube and for the non-air

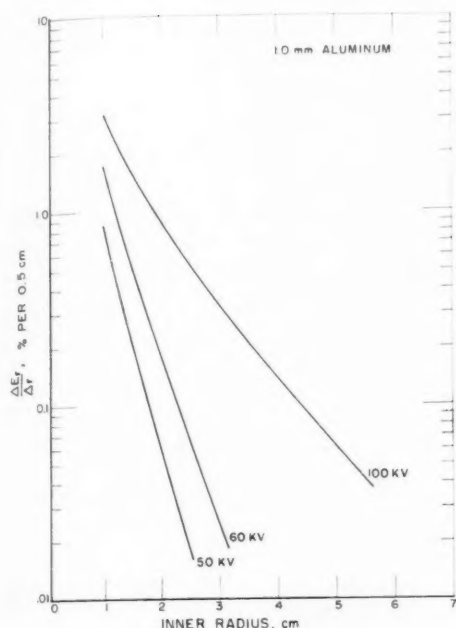


Fig. 13. Loss of electron-produced ionization per 0.5 cm. radius increment for the x-rays of Fig. 9.

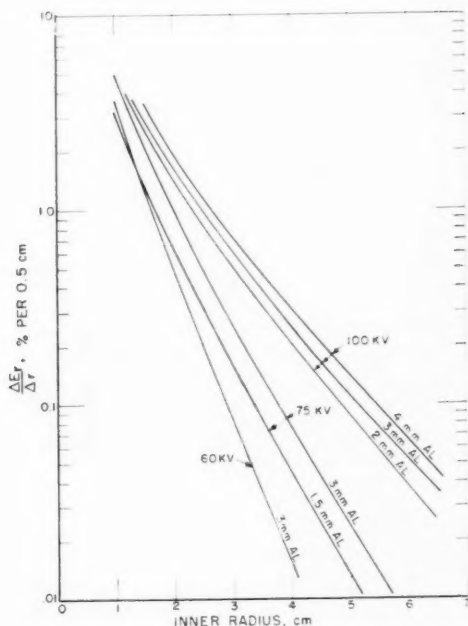


Fig. 14. Loss of electron-produced ionization per 0.5 cm. radius increment for the x-rays of Fig. 10.

equivalence of the plastic substance by raising it until it coincided with the electron-plus-photon curve at large distances from the beam, where the primary electron contribution was negligible. The primary electron contribution was not negligible for the highest energy x-ray beams used in this experiment. For these cases the non-air equivalence was estimated from the data of Attix and DeLaVergne (7).

The presence of the tube tended to distort the electric field near the center of the chamber. This distortion would produce an appreciable error in the slope of the photon curve. The magnitude of this distortion was determined by irradiating the entire chamber uniformly from one side with Cs^{137} gamma rays.³ The ionization was sampled with the tube in place and found to be uniform to ± 1 per cent over all but the center three collecting strips. The photon curve was therefore extrapolated in this central region.

³ This method of checking the field distortion was suggested by H. O. Wyckoff.

Figures 7-10 show the percentage of electron loss outside of a given radius from the x-ray beam. The results are computed in cylindrical co-ordinates (7) for a zero-diameter beam (8) (air at 26° C. and 760 mm. Hg). Figures 11-14 show the electron contribution per radius increment, $\Delta E/\Delta r$, at different inner radii. Agreement with the work of Attix and DeLaVergne is seen to be excellent. Figures 7-14 can be used to determine the electron loss in any particular free-air chamber. These curves assume that the electrons striking the plate system are absorbed. The back-scatter of electrons from aluminum is at least 20 per cent in this energy region (9). Thus, in designing a chamber, the electron loss should be kept smaller than 1 per cent if the error due to back-scatter is to be kept to a few tenths of 1 per cent.

Figure 15 shows the variation of the scattered photon contribution with radius. The curve has been arbitrarily normalized to 1 at the greatest radius used in this experiment. The shape of the curve was

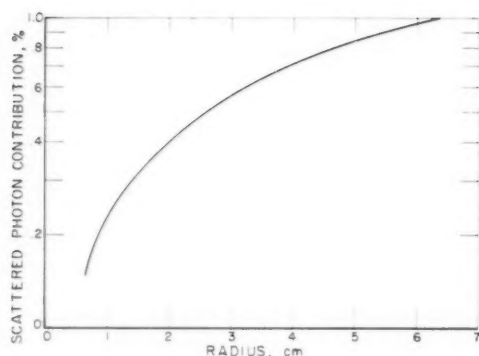


Fig. 15. Contribution of secondary photon ionization within different radii from a zero-diameter x-ray beam. Multiply the ordinate by the factors in Table I to obtain the contribution in per cent of the total primary electron ionization for the various kilovoltages and filtrations.

TABLE I: MULTIPLIERS FOR ORDINATE OF FIGURE 15

Kvcp	Inherent Filtration	0.5 mm. Al	1 mm. Al	1.5 mm. Al	2 mm. Al	3 mm. Al	4 mm. Al
20	0.9	0.9	...	...	...	...	...
30	0.9	0.75	...	...	...	...	...
50	0.9	0.7	0.6	...	...	...	...
60	0.9	...	0.6	...	...	0.55	...
75	0.9	0.6	...	0.55	...	0.5	...
100	0.9	0.5	0.5	...	0.5	0.5	0.4

found to be independent of the energy of the x-ray beam. The magnitude of the photon contribution varied with the kilovoltage and filtration used. The ordinate of Figure 15 must be multiplied by the multipliers in Table I to obtain the photon contribution within a given radius for a zero-diameter beam in per cent of the total electron contribution. Table II compares these results with the work of Attix and DeLaVergne for the higher kilovoltages and heavier filtrations. Their work involved an extrapolation of the scattered photon curve in the region where the radius was less than 5 cm. The present experiment, which measured the slope in this region, indicates that the extrapolation underestimated the scattered photon correction by about 0.07 per cent. The two experiments agree to 0.1 or 0.2 per cent when this correction is applied to their results.

The present experiment was done with about 1 meter of air between the x-ray

tube and the collecting region. Longer air paths would selectively filter the lower energy components of the x-ray beam, thereby increasing its effective energy. The effect of longer air paths on the electron and photon contributions was determined for 20 kv x-rays with inherent filtration and found to be negligible. The zero-beam diameter approximation was checked experimentally with 20 kv x-rays (inherent filtration) for 0.5 and 1.0 cm. diameter beams and found to be valid.

AIR ATTENUATION AND OTHER FACTORS

The field distortion study previously described makes possible design of a free-air chamber with a 5-cm. air path between

TABLE II: COMPARISON WITH WORK OF ATTIX AND DELAVERGNE

Energy	Photon Contribution Within 5 cm. Radius, in Per Cent		
	Present Experiment	Attix	Attix, Corrected
100 kvcp, 4 mm. Al	0.32	0.13	0.20
75 kvcp, 3 mm. Al	0.41	0.14	0.21
60 kvcp, 3 mm. Al	0.44	0.14	0.21

the chamber diaphragm and the center of the collector. If there is at least 1 meter of air plus 0.5 mm. of aluminum between the x-ray target and the free-air chamber, the air attenuation data of Day and Taylor (10) can be used with only small errors. A redetermination of the air attenuation corrections yielded corrections for a 5-cm. air path 0.15 per cent higher than the values given by those workers. For inherent filtration the difference was 0.2 per cent or less from 100 kv down to 50 kv; about 0.3 per cent at 30 kv. The differences imply a higher inherent filtration for the x-ray tube used by Day and Taylor.

TABLE III: HALF-VALUE LAYERS IN MM. OF ALUMINUM

Kvcp	Inherent Filtration	0.5 mm. Al Filtration	1 mm. Al Filtration	1.5 mm. Al Filtration	2 mm. Al Filtration	3 mm. Al Filtration	4 mm. Al Filtration
20	0.07 (0.08)*	0.24 (0.25)	...	...	...	...	...
30	0.08 (0.10)	0.36 (0.40)	...	...	...	...	...
50	0.09 (0.10)	0.50 (0.58)	0.88 (1.1)	...	...	...	...
60	0.09	...	1.1	...	...	2.1	...
75	0.09	0.66	...	1.6	...	2.5	...
100	0.09 (0.11)	0.77	1.4 (2.1)	...	2.5	3.5	3.9

* The values obtained by Day and Taylor are given in parentheses.

Tungsten from the filament may have evaporated onto the beryllium window, increasing the inherent filtration. This, in turn, would decrease the air-attenuation corrections and increase the half-value layers that would be measured. The half-value layers measured by Day and Taylor are indeed larger than those that were measured in the present experiment (Table III). The air attenuation should be measured in each laboratory at the lower kilovoltages and filtrations if the highest accuracy is to be attained.

The roentgen is defined for a mass of *dry* air. Corrections for the humidity of the air may amount to ± 0.3 per cent in the soft x-ray region under ordinary laboratory conditions. Methods of calculating this correction are found in *Handbook 64*.

SUMMARY

The general requirements for the design of standard free-air ionization chambers have been summarized in National Bureau of Standards *Handbook 64*. The present experiment has determined supplementary criteria for the soft x-ray region. The maximum uncertainties in the factors investigated here may be summarized as follows: field distortion and errors in measuring the length of the collector ± 0.2 per cent, electron losses ± 0.1 per cent, scattered photon contribution ± 0.2 per cent and air attenuation ± 0.2 per cent. These values, combined with the estimates in *Handbook 64* for uncertainties in the

diaphragm area, charge measurement, etc., yield a probable limit of error of ± 0.5 per cent for the determination of exposure dose in roentgens in the soft x-ray region.

NOTE: The author expresses his gratitude to H. O. Wyckoff, F. H. Attix, S. W. Smith, and M. G. Ehrlich for many helpful discussions in the course of the experiment.

National Bureau of Standards
Washington 25, D. C.

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(Pro le summario in interlingua, vider le pagina sequente)

SUMMARIO IN INTERLINGUA

Construction de Cameras de Ionisation a Aere Libere pro le Region de Radios X Molle (20 a 100 kv)

Criterios de construction esseva determinate pro cameras standard de ionisation a aere libere pro le region del molle radios X. Un tubo Roentgen a pecia de concentration de wolfram e un fenestra de beryllium de 2 mm esseva utilisate con potentiales excitatori de inter 20 e 100 kvcp. Usque a 4 mm de aluminium esseva addite al filtration inherente del tubo.

Le distortion del campo electric al electrodo colligente, causate per le proximitate del systema de bandas de guarda, esseva studiate como function del distantia inter le bandas e le electrodo colligente,

del distantia centro-a-centro inter le bandas, e del spissitate del bandas.

Le distribution radial del primari ionisation electronic e del dispergite ionisation que es photonicamente inducite esseva mesurate. Le accordo con le investigationes de Attix e DeLaVergne es bon. Es discutate altere factores corrective que es de importantia particular in le region de radios X molle. Le datos indica que le mesuration del dosage de exposition in roentgens pote esser facite in iste region de energia con un probabile margine de error de $\pm 0,5$ pro cento.



Use of Magnetic Tape for Recording Radioactivity¹

SOLOMON N. ALBERT, M.D., H. N. ECCLESTON, JR., M.D., T. FUJITA, M.D.,
CHARLES H. HUNTER, M.D., and CHALOM A. ALBERT, M.D.

RADIOACTIVE ISOTOPES are frequently used as tracer material for diagnostic purposes. The principle employed for determining rate of blood flow is based on a dilution or elimination rate of the administered tracer dose. Activity rate is measured with a suitable detector and recording system.

METHOD

A suitable detector probe is activated to the proper voltage level by an appropriate power supply source, either from a scaler or rate-meter unit. The output from the scaler or rate meter is directly attached to the microphone input of the tape recorder. The simultaneous use of tape recording

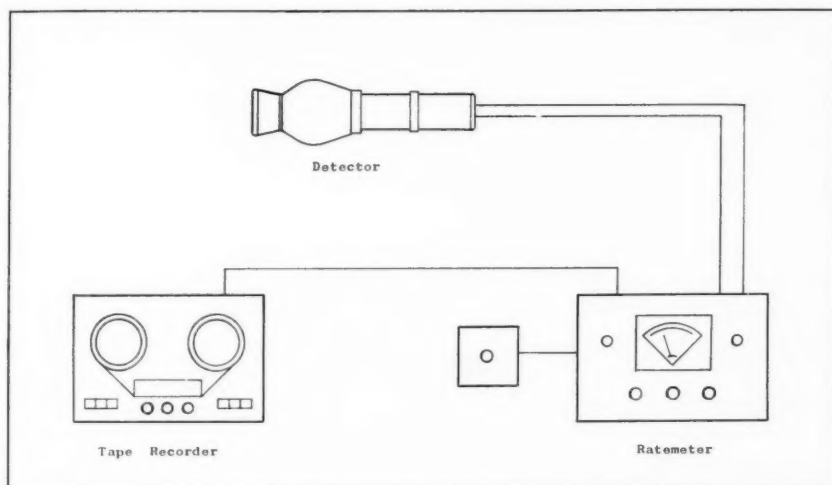


Fig. 1. Scheme for tape recording radioactivity by tapping speaker output of ratemeter.

Interpretation of disappearance curves is at times rendered difficult because of a weak dose of radioactive material introduced into the system or inadequate settings of the rate meter as to scaling and time factors.

To obviate loss of valuable data, a recording system that could register all impulses emitted by the detector probe would be of value. These could then be reproduced at leisure through a scaler or integrating rate meter. Commercial tape recorders have proved adaptable for registering radioactive disintegration impulses.

does not interfere with the routine recording system obtained directly from a rate meter or while the counting of radioactivity is in progress.

RATE METER

1. *Nuclear-Chicago Rate Meter, Labitron, or Survey Meter.* The speaker leads, or phone plugs, are tapped and connected directly to the microphone input of the tape recorder (Fig. 1).

2. *Pickler Rate Meter.* The amplifier output, contact point 8 on the J4 amplifier plug in the socket, is tapped and connected

¹ From the Anesthesiology Research Laboratory and Radioisotope Laboratory, District of Columbia General Hospital, Washington, D. C. Project supported in part by Atomic Energy Commission Contracts AT (30-1) 1820 and AT (30-1) 2277 with George Washington University, Washington, D. C.

Accepted for publication in February 1959.

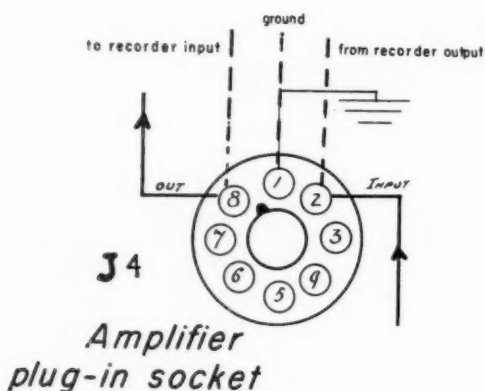


Fig. 2. Scheme of J4 plug in socket and points at which connections are made to and from the tape recorder.

Phillips tape recorder offers wider flexibility in recording and for replay. Normally a 3 3/4 inch per second tape recording is adequate.

REPLAY OF TAPE RECORDING

Tape recordings can be replayed by simply connecting the tape recorder output to the input of the rate meter. For counting purposes, it may be connected to the input of a scaler.

1. *Nuclear-Chicago Rate Meter* (Model #1620): A small Fisher transistor pre-amplifier is employed. The tape recorder speaker output is connected to the pre-

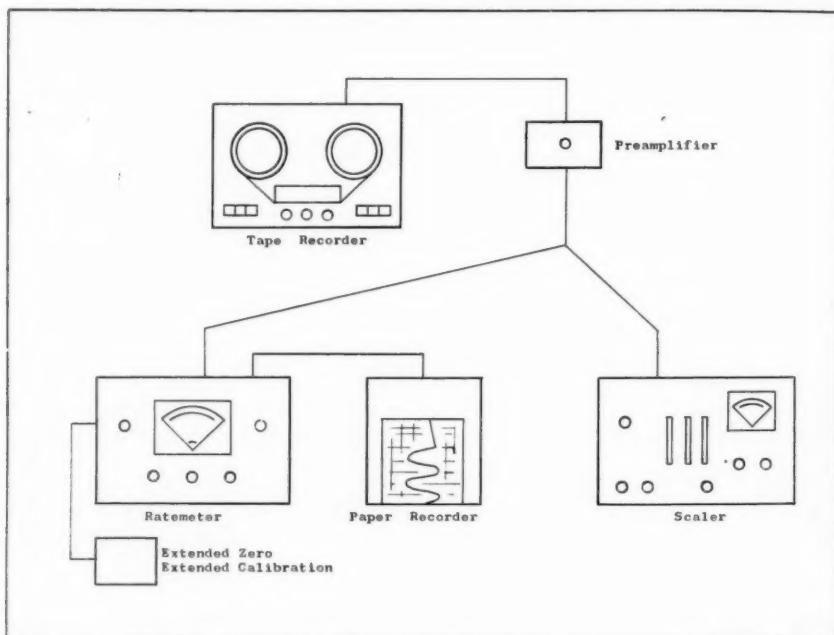


Fig. 3. Reproduction of tape recording of radioactivity through a pre-amplifier to the input of a scaler for absolute counting or through a rate meter for chart recording.

to the microphone input of the tape recorder.

Settings of the rate meter, sensitivity, and scaling rate are immaterial for magnetic tape recording purposes (Fig. 2).

TAPE SPEED FOR RECORDING

Tape speed for recording is dependent on activity rate. A three-speed Norelco

amplifier input and the preamplifier output to the scaler or rate-meter input (Fig. 3).

2. *Nuclear-Chicago Labitron* (Model #1619A): No preamplifier is necessary. The recorder output is directly connected to the input.

3. *Picker Counting Rate Meter* (Model #2805): Tape recorder output is attached

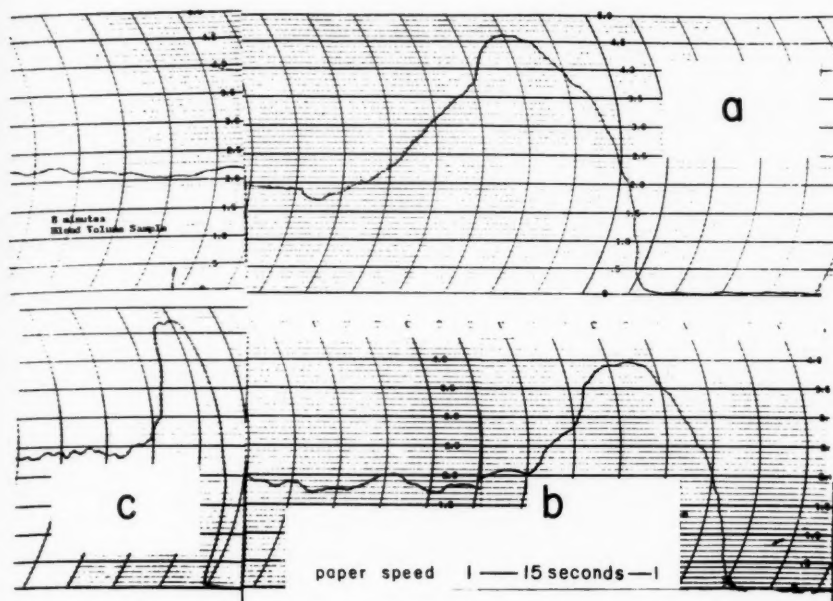


Fig. 4. Reproduction of three cardiac output dilution curves from tape recordings. a. Control. Dosage 10 mme Cr^{51} . Blood volume 3,005. Cardiac output 3,900. b. Adrenalin infusion. Dosage 10 mme Cr^{51} . Blood volume 3,320. Cardiac output 6,630. c. Hypothermia. Dosage 10 mme Cr^{51} . Blood volume 2,530. Cardiac output 6,325.

directly to the rate-meter preamplifier input; contact point 2 on the j4 amplifier plug in socket.

The count rate can be doubled or halved depending on the tape speed at which the recording is replayed. With a replay speed twice the recording speed, counts are doubled and counting time is halved. This permits reproduction of low-activity curves and converts a poor dilution or elimination curve into one which can be easily interpreted (Fig. 4).

In order to obtain rapid and minor changes in activity rate clearly, a reduced replay speed may be employed.

PHONO TRIX TAPE RECORDER

This tape recorder operates on 4 flash-

light batteries. It does not function on preset fixed speeds but has a variable speed control of 1 to 8 inches per second, and a wider flexibility. In order to standardize the speed limit, a 60-cycle feed is recorded for a 30-second period as a control. By varying the replay speed, the height of the curve and duration are compared to the 60-cycle standard.

SUMMARY

A simple adaptation of magnetic tape recorders to rate meters or scalars has been devised. This can be used for registering impulses from detectors in order to record and measure radioactivity.

Department of Anesthesiology
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(Pro le summario in interlingua, vider le pagina sequente)

SUMMARIO IN INTERLINGUA

Le Uso de Bandas Magnetic in le Registration de Radioactivitate

Le uso de isotopos radioactive como traciatores pro objectivos diagnostic es basate super le tempo de dilution o elimination del dose administrate. Le interpretation del curvas de dilution o elimination, tamen, es frequentemente difficile a causa del debilitate del dose de materia radioactive o a causa de inadequate dispositivos de lectura in le mesurator de

intensitate con respecto a factores de scalation e tempore. Un systema de registration pareva desirabile que registrarea omne le impulsos transmittite per le detector e permetterea lor reproduction calmemente per un scalator o ratiometro integrational. Le autores describe un simple adaptation de registratores a banda magnetic pro iste objectivo.



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EDITORIAL

Radiation Control at the Grassroots

The first place that most of us have looked to see if radiation exposures can be reduced has been in our own radiological offices and departments. Protection, like charity, properly starts at home, and self-inspection and re-evaluation of our own technics have been a worthwhile activity. By now, such efforts in radiation control have been sufficiently emphasized that our equipment and procedures should have been brought up to modern acceptable standards. But is this enough? Is the radiologist's responsibility completed at this point? As part of the small group with pertinent specialist education and comprehensive understanding of radiation problems, we can offer our talents at least to our community and regional situation. As civic-minded citizens we shall find here a real opportunity for service which no one else can provide.

The need is apparent. Elsewhere in this issue of *RADIOLOGY* is a report of a community survey of radiation exposure from medical fluoroscopes. Fluoroscopes were chosen for this investigation because they contribute a major proportion to both somatic and gonadal radiation exposure of the population. In this study of 81 fluoroscopes in the Philadelphia area, the findings show that both apparatus and technics are frequently not up to acceptable or desirable levels. Only about half of the fluoroscopes were producing exposure dose rates considered acceptably low. Less than one out of ten machines met more critical performance standards.

The apparatus of radiologists and that found in hospitals was generally better than the apparatus of non-radiologists, but need for some improvement was apparent in all groups. More remarkable, however, was the finding that 90 per cent

of these fluoroscopes could be brought up to acceptable standards by relatively minor and inexpensive modifications.

The medical action taken in this community was voluntary and self-generated. A Radiation Committee of the County Medical Society made arrangements with a commercial radiological safety group to provide comprehensive inspection and analysis of fluoroscopic apparatus for its members. A cost of approximately \$40 per machine includes a written report of the findings and recommendations, but does not include alterations unless they are so simple as to require no additional charge by the inspection physicist. More extensive alterations were considered to be the province of regular x-ray service organizations. To date about 100 members of the Philadelphia County Medical Society have availed themselves of this service. This appears to be a plan suitable for wide use and one which can be initiated by radiologists in their own localities.

The problems of medical radiation control involve much more, of course, than correcting deficiencies in apparatus alone. Considerably more important are the methods of use of the apparatus and the judgment involved in choice of procedures for individual patients. These can be improved only by educational methods which emphasize adequate dark adaptation before fluoroscopy, reduction in the time of fluoroscopic exposure as far as is consistent with obtaining the needed information, and limitation of fluoroscopy to situations where it is specifically needed. The emphasis on control of fluoroscopy seems justified because it is not so intrinsically self-limiting in exposure as are radiographic procedures, but the latter should not be neglected. The numerous papers

which have appeared in our journals, the publications of the American College of Radiology, and its recently released movie furnish source material for such educational efforts. Here also, however, the personal attention of radiologists is needed to implement this effort across the country and at local levels.

If we grant that the need is obvious and that these two forms of action are appropriate, we as radiologists have much to gain in spearheading them. The opportunity for constructive leadership is ours as well as moral obligation to be of service in a field of special competence. It seems worth trying at *your* grassroots.

RICHARD H. CHAMBERLAIN, M.D.



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ANNOUNCEMENTS AND BOOK REVIEWS

EAST TENNESSEE RADIOLOGICAL SOCIETY

At a recent meeting of the East Tennessee Radiological Society at Gatlinburg, Eugene Abercrombie, M.D., of Knoxville, assumed the Presidency. Elected to office were: Vice-President, James J. Range, M.D., Johnson City; President-Elect, John M. Higgason, M.D., Chattanooga; Secretary-Treasurer, J. Marsh Frere, Jr., M.D., 205 Medical Arts Building, Knoxville.

FLORIDA WEST COAST RADIOLOGICAL SOCIETY

Newly elected officers of the Florida West Coast Radiological Society are: Charles M. Gray, M.D., Tampa, President; James Shelden, M.D., Lakeland, Vice-President; Joseph C. Rush, M.D., Mease Hospital, Dunedin, Secretary-Treasurer. The Society meets quarterly at the Tampa Terrace Hotel.

NEBRASKA RADIOLOGICAL SOCIETY

At a recent meeting of the Nebraska Radiological Society the following officers were elected: President, Shaun Gunderson, M.D., Omaha; President-Elect, Warren Bradley, M.D., Lincoln; Secretary-Treasurer, Ronald E. Waggener, M.D., Nebraska Methodist Hospital, Omaha.

ISOTOPE COURSE

QUEENS HOSPITAL CENTER, NEW YORK

A four-month course in the Medical Uses of Radioactive Isotopes is being offered at the Queens Hospital Center, Department of Hospitals, City of New York, by the Radiation Medicine Department, beginning Feb. 9, 1960. Weekly five-hour sessions will include lectures, laboratory exercises, and clinical management of patients. Tuition is \$275.00.

Requests for further information should be sent to Dr. Philip J. Kahan, Supervising Medical Superintendent, Queens Hospital Center, 82-68 164th St., Jamaica 32, N. Y.

POSTGRADUATE COURSE IN RADIOLOGY UNIVERSITY OF KANSAS

The annual postgraduate meeting in Radiology at the University of Kansas Medical Center will be held Feb. 8-10, 1960. Further information may be obtained from G. M. Tice, M.D., University of Kansas Medical Center, Kansas City 12, Kans.

LOS ANGELES RADIOLOGICAL SOCIETY MIDWINTER CONFERENCE

The Twelfth Annual Midwinter Radiological

Conference, sponsored by the Los Angeles Radiological Society, will be held at the Statler Hotel, Los Angeles, on Saturday and Sunday, Jan. 30-31, 1960.

An outstanding program has been arranged. Guest speakers will be Dr. John A. Evans, New York; Professor Knut Lindblom, Stockholm, Sweden; Dr. James J. Nickson, New York; Dr. E. Rohan Williams, London, England.

The Conference fee of \$20.00 includes two luncheon meetings featuring questions and answers. A banquet (\$7.50 per plate) preceded by cocktails will be held Saturday evening. Reservations may be made through Dr. Sidney D. Zucherman, 3741 Stocker St., Los Angeles 8, Calif. Hotel reservations should be made promptly through the Convention Manager, Statler Hotel, Los Angeles, Calif.

CARDIOVASCULAR ROENTGENOLOGY FELLOWSHIP

A Fellowship in Cardiovascular Roentgenology will be open Jan. 1, 1960, in the Department of Radiology at the University of California in Los Angeles. In support of this, the National Institutes of Health are providing \$12,000. The purpose is to acquaint young radiologists with the nature of academic radiology, particularly in the fields of cardiovascular teaching and research. Candidates should have completed or approximately completed their residency requirements in Radiology or Diagnostic Radiology and preferably should be eligible for their Board examinations.

In Memoriam

AMOS R. SHIRLEY, M.D.
1887-1959

Dr. Amos Shirley, retired Chief of X-ray Services for the Veterans Administration regional office, Milwaukee, died recently of a heart ailment.

Dr. Shirley was born in Coventry, England, in 1887. He received his medical education at Columbia University, New York, and the University of Vermont. Thirty-seven years of his life were spent in Federal service. Prior to joining the regional office of the Veterans Administration in Milwaukee in 1946, he was for eleven years Chief of Radiology at the VA Center at Wood, Wisc.

Dr. Shirley was a member of the Radiological Society of North America, the Milwaukee Roentgen Ray Society, and a service fellow in the American Medical Association. He was past state commander of the Military Order of World Wars and of its Milwaukee chapter. He was a lieutenant colonel in the army in World War II and held a post with the war risk insurance bureau.

Surviving are his wife, Harriet, a daughter, Mrs. Ruth Harmon, Vero Beach, Fla., and a son, Amos, Jr., Milwaukee.

and 48 tables. Published by Dr. Alfred Hühig Verlag, Wilckensstrasse 3, Heidelberg, Germany, 1959. Price DM 18.—.

Books Received

Books received are acknowledged under this heading, and such notice may be regarded as recognition of the courtesy of the sender. Reviews will be published in the interest of our readers and as space permits.

ATLAS OF ROENTGENOGRAPHIC POSITIONS. By VINITA MERRILL, while Educational Director, Picker X-ray Corporation. A two-volume work of 674 pages, with numerous illustrations. Published by The C. V. Mosby Company, St. Louis, 2d ed., 1959. Price \$32.50.

BIOPHYSICAL SCIENCE—A STUDY PROGRAM. Planned and edited by J. L. ONCLEY, Editor-in-Chief, F. O. SCHMITT, R. C. WILLIAMS, M. D. ROSENBERG, and R. H. BOLT, for the Biophysics and Biophysical Chemistry Study Section of the National Institutes of Health, Public Health Service, U. S. Department of Health, Education, and Welfare. A volume of 610 pages, with numerous figures and tables. Published in the Reviews of Modern Physics, January and April, 1959, and by John Wiley & Sons, Inc., New York, N. Y., 1959. Price \$6.50.

L'ÉPAULE EN PRATIQUE RHUMATOLOGIQUE. By S. DE SÈZE, A. RYCKEWAERT, and M. MAÎTRE. Travail du Centre de rhumatologie Vigg-Petersen de l'Hôpital Lariboisière (Paris). A monograph of 170 pages, with 208 figures. Published by Masson & Cie, 120, Blvd. Saint-Germain, Paris, VI^e, France, 1959. Price 3,800 fr.

RADIOGRAPHIE DU CRÂNE ET DE LA FACE DANS LA MALADIE OSSEUSE DE PAGET. By J.-A. LIÈVRE, Médecin des Hôpitaux de Paris, and H. FISCHGOLD, Électroradiologiste des Hôpitaux de Paris. Radio-diagnostic et radio-anatomie de précision. A volume of 132 pages, with 75 figures. Published by Masson & Cie, 120, Blvd. Saint-Germain, Paris, VI^e, France, 1959. Price 4,000 fr.

DETAILERKENNBARKEIT UND DOSIS BEI DER RÖNTGENDURCHLEUCHTUNG: DURCHLEUCHTUNGSSCHIRME UND BILDVERSTÄRKER. By DR. MED. WOLFGANG FRIK, Privatdozent der medizinische Strahlenkunde, Röntgenabteilung der Medizinischen Klinik mit Poliklinik der Universität Erlangen. Band 6, Medizin: Theorie und Klinik in Einzeldarstellungen, edited by Professor Dr. med. Hans Schaefer, Heidelberg, unter Mitwirkung von Prof. Dr. G. Bodechtel, Munich, et al. A monograph of 168 pages, with 35 figures

Book Reviews

AN ATLAS OF NORMAL RADIOGRAPHIC ANATOMY. By ISADORE MESCHAN, M.A., M.D., Professor and Director, Department of Radiology, Bowman Gray School of Medicine of Wake Forest College, Winston-Salem, N. C.; Consultant, Walter Reed Army Medical Center, Washington, D.C.; Formerly Professor and Head of the Department of Radiology, University of Arkansas School of Medicine. With the assistance of R. M. F. FARRER-MESCHAN, M.B., B.S. (Melbourne, Australia), M.D., Research Associate, Department of Radiology, Bowman Gray School of Medicine of Wake Forest College, Winston-Salem, N. C. A volume of 760 pages, with 1,446 illustrations on 412 figures. Published by W. B. Saunders Co., Philadelphia, Penna., 2d ed., 1959. Price \$16.00.

The reception which this excellent work received when it first appeared in 1951 was such that subsequent editions to keep pace with expanding knowledge were inevitable. The text has now been revised and numerous additions have been made. A chapter on Radiation Protection has been included. The chapter on Bone Growth and Development has been rewritten, and the chapter on The Brain has been modified, with greater emphasis on angiography. Account has been taken of new developments in the study of the heart and great vessels, and advances in anatomic knowledge of the gastrointestinal tract, especially the physiology of swallowing, have been detailed. Other lesser changes have also been made.

Good judgment has been shown in the choice of illustrations. The reproductions, in the negative phase, are excellent. The line drawings are unusually well done and clearly labeled. A comprehensive index is added. Pertinent references are appended to each chapter.

This book can be recommended to the experienced radiologist as well as to the resident and student as an invaluable source of basic information.

ATLAS OF ROENTGENOGRAPHIC MEASUREMENT. By LEE B. LUSTED, M.D., Associate Professor of Radiology, University of Rochester School of Medicine and Dentistry, Rochester, N. Y., and THEODORE E. KEATS, M.D., Professor of Radiology, University of Missouri School of Medicine, Columbia, Mo. A volume of 176 pages, with 119 figures. Published by The Year Book Publishers, Inc., Chicago, Ill., 1959. Price \$9.00.

In the early days of roentgenology the standards of normal anatomy and measurements were largely derived from texts on morbid anatomy and empiric observation. Later, careful studies established nor-

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mal measurements from the living which were of immense value to radiologists. These were available, but scattered in the literature.

The authors of this *Atlas* have brought together in one volume many of these measurements for ready reference. No attempt has been made to record every measurement but the data believed to be most reliable and practical have been chosen.

Following an introductory section on Geometric Distortion of the Roentgen Image and Its Correction, the subject material is divided into nine categories, of which the skeletal system occupies approximately half the volume. Other chapters are devoted to the central nervous system; neck; respiratory system; cardiovascular system; gastrointestinal system; spleen and adrenal glands; urinary tract; pelvimetry and fetometry.

A uniform method of presentation has been adopted throughout the work. Either a roentgenogram or a drawing derived from a roentgenogram is reproduced and the accompanying text is presented under three heads: The *technic* of radiography in the example under consideration is outlined, the *measurements* derived from the film are stated, and their *source* is specified, whether it be a series of cases observed by the authors or reports in the literature. The inclusion of this source material will save the reader many weary hours which might otherwise be spent in a search for the original studies by which the standards were established.

Excellent drawings illustrate the methods employed in making the measurements. A useful index is included.

This volume is indispensable for radiologists and students as well as anatomists.

DIAGNOSIS OF CONGENITAL HEART DISEASE: A CLINICAL AND TECHNICAL STUDY BY THE RADIOLOGIC TEAM OF THE PEDIATRIC CLINIC, KAROLINSKA SJUKHUSET, STOCKHOLM. By Sven R. KJELLBERG, EDGAR MANNHEIMER, ULF RUDHE, AND BENGT JONSSON. A volume of 866 pages, with 727 figures. Published by The Year Book Publishers, Inc., Chicago, Ill., 2d ed., 1959. Price \$28.00.

The first edition of this work, published in 1955, was based on 396 cases of congenital heart disease investigated in the Pediatric Clinic of Karolinska Sjukhuset, Stockholm. This case material has now nearly doubled in amount, additional types of cardiac anomalies have been recognized, and new methods of examination have come into vogue. All methods utilized in investigating congenital heart disease are presented in this new edition, with appropriate emphasis on roentgenology, including angiocardiology. The cases selected for presentation are representative of the entire field of congenital heart disease.

The embryology, roentgen anatomy, physiology of the heart, and technics used in study of congenital heart disease are presented adequately, but not in ex-

haustive detail, in separate chapters preceding the account of the case material. Separate chapters are then devoted to the major cardiovascular defects, such as pulmonary stenosis, atrial septal defect, ventricular septal defect, etc., complicating lesions being included as variations of these. The discussion of each condition includes brief consideration of the embryological defects and the anatomical and physiological features, as well as the clinical findings, special laboratory tests (phonocardiogram, electrocardiogram, vascular pulse recordings, elektrokymograms, and catheterization findings), roentgen appearance, and angiocardigrams when these contribute to the diagnosis.

The text is well written and the photographic and radiographic reproductions are excellent.

DIAGNOSTIC ROENTGENOLOGY. ROSS GOLDEN, M.D., editor, Visiting Professor of Radiology, University of California at Los Angeles; Emeritus Professor of Radiology, College of Physicians and Surgeons, Columbia University; formerly Director of the Radiological Service, Presbyterian Hospital, New York. [Renewal pages for Vols. I-III, including: The Roentgen-Ray Examination of the Paranasal Sinuses and the Mastoids, by G. W. Grier, M.D.; Roentgenologic Diagnosis of Diseases of the Urinary Tract, by Marcy L. Sussman, M.D., and George Jacobson, M.D.; The Roentgen Diagnosis of Fractures and Dislocations, by L. Henry Garland, M.B.; Dental Roentgenology, by E. V. Zegarelli, D.D.S.; New Index Pages.] Loose-leaf renewal pages 2.1-2.49; 8.1-8.167; 11.1-11.32; 12.1-12.82; 1169-1210. Published by Williams & Wilkins Co., Baltimore 2, Md., 1959. Price \$60.00.

Four new sections of the loose-leaf compendium on Diagnostic Roentgenology inaugurated in 1936 under the editorship of Dr. Ross Golden lend emphasis—if such is needed—to the expanding scope of radiology. The passing years have witnessed many advances in technic and diagnosis which have necessitated revision and expansion of earlier contributions, to which the loose-leaf format is particularly adaptable. The following chapters make up the present revision.

In Volume I, the section on Paranasal Sinuses and Mastoids has been rewritten by Dr. George W. Grier, being expanded from 25 to 49 pages. New material has been added on technic and on sinusitis in children. Many new illustrations are presented, and others have been replaced to advantage. This section has been definitely improved.

In Volume II, the section on Diseases of the Urinary Tract has been rewritten by Drs. Marcy R. Sussman and George Jacobson, being increased from 131 to 167 pages. About 75 additional illustrations have been included and many new ones have been substituted for older views. Unfortunately some are in the negative and some in the positive phase, which detracts somewhat from continuity. The section, however, shows improvement and modernization.

In Volume III, Dr. L. Henry Garland has revised the section on Fractures and Dislocations. This has been expanded only slightly and, while the illustrations are about the same in number, many well advised substitutions have been made. Improvements have also been made in the text.

Dental Roentgenology, also in Volume III, now occupies 82 instead of 38 pages. The text is much more inclusive and discusses diseases and tumors which affect the mandible much more extensively than was done earlier. Both illustrations and text are greatly improved.

These new pages represent the policy of the Editor and Publishers of keeping these volumes up to date by periodic revision of the various sections. The entire work is recommended as an excellent source of information on diagnostic roentgenology for students, residents, and practicing radiologists.

MEDICAL RADIOGRAPHIC TECHNIC. Prepared by Technical Service, X-Ray Department, General Electric Company, under the original editorial supervision of the late GLENN W. FILES. Revision by WILLIAM L. BLOOM, JR., JOHN L. HOLLENBACH, R. T., JAMES A. MORGAN, R.T., AND JOHN B. THOMAS, R.T. A volume of 386 pages, with numerous figures and tables. Published by Charles C Thomas, Springfield, Ill., 2d ed., 1959. Price \$11.00.

The late Glenn W. Files supervised the original publication of *Medical Radiographic Technic* in 1943. With the collaboration of his associates in the X-Ray Department of the General Electric Company, a textbook was compiled which met with such popular demand that in fifteen years eleven printings were required. Now the text has been revised and much pertinent information has been added to make a more complete handbook. Angiocardiology, cerebral angiography, abdominal aortography, venography, and many other specialized procedures, including magnification technics, are adequately discussed and illustrated by excellent reproductions. These additions to a text, which has already proved its usefulness, will be most helpful to the radiologist and his teaching staff.

PROTECTION IN DIAGNOSTIC RADIOLOGY. Edited by B. P. SONNENBLICK. A volume of 346 pages, with figures and tables. Published by Rutgers University Press, New Brunswick, N. J., 1959. Price \$7.50.

This compilation of articles previously published in various medical journals on the subject of radiation protection not only covers diagnostic radiology, as indicated by the title, but also includes isotope therapy. Probably no two people would agree on the articles to be selected for such a book, but the present choice is a good one. The book jacket states that the work is meant for "physicians, dentists, osteopaths,

veterinarians, chiropractors, podiatrists, and their technical assistants." The radiologist will have little need of it, since he should be familiar with the journals from which the articles were taken. It is convenient, however, to have scattered material on a given subject collected in a single volume.

KLINIK UND PRAXIS DER UROLOGIE: KLINIK, INDIKATION, DIAGNOSTIK, OPERATIVE UND INSTRUMENTELLE EINGRIFFE, NACHBEHANDLUNG. In zwei Bände. By PROF. DR. WERNER STAEHLER, Leiter der Urologischen Abteilung der Chirurgischen Universitätsklinik Tübingen. With Foreword by Prof. Dr. Th. Naegeli, Tübingen. Band I, 892 pages, with 1,034 figures; Band II, 864 pages, with 641 illustrations and author and subject indexes. Published by Georg Thieme, Herdweg 63, (14a) Stuttgart, Germany, 1959. Price DM 240.—(\$57.15), per volume. Distributed in the United States and Canada by the Intercontinental Medical Book Corporation, New York 16, N. Y.

In 1941, Dr. Staehler published a book, *Operative Cystoscopy*, the success of which stimulated him to undertake a broader, more definitive urologic work to include clinical practice, roentgenology, cystoscopy, endoscopic surgery, and open surgery of the diseases of the urogenital system. The results of these studies appear in two volumes, under two main headings: Medical Urology and Technical Aspects, the latter being further divided into Diagnosis and Therapy. A brief introductory chapter of a score of pages outlines urologic history, defines the terms which are used in the book, lists abbreviations, and also enumerates current standard urologic texts. The usual sequence of subjects begins with the chapter on developmental anomalies and carries through inflammatory changes in the kidneys, urogenital tuberculosis, renal, ureteral and bladder calculi, ureteral obstruction, bladder neck obstruction and tumors, in Volume I, and anuria, nephritis, circulatory disturbances, and hematuria, trauma, foreign bodies, etc., and diseases of the male genital tract, in Volume II. The division of the material is on the basis of the type of disease and not specific organ pathology. The descriptions and deductions of the basic disease groups are excellent with good augmentation by case histories, quotations from hospital records, and roentgenograms.

Volume II contains also the chapters devoted to technic, including blood chemistry, function tests, roentgenography, cystoscopy, anesthetic procedures, catheterization, and surgical technics. An index to the two volumes is appended.

This publication is of the usual high quality maintained by Georg Thieme Verlag in Stuttgart: the books are well bound, the illustrations are good, some in color, and the typography is conducive to easy reading.

RÖNTGENDIAGNOSTIK BEIM NEUGEBORENEN UND SÄUGLING. By DR. HERMANN G. WOLF, Assistent der Universitäts-Kinderklinik Wien. With Foreword by Prof. Dr. K. Kundratitz, Vorstand der Universitäts-Kinderklinik Wien. A volume of 318 pages, with 570 illustrations on 370 figures. Published by Wilhelm Maudrich, Franz-Josefs-Kai 23, Vienna 1, Austria, 1959. Price \$23.60.

This carefully composed text is a summary of the author's experience in pediatric roentgenology since 1946. Because this is only the second publication on x-ray diagnosis to emerge from the Childrens' Clinic of the University of Vienna—the first being Swoboda's work on the skeleton of the child—one can be certain that the book is not part of a literary flooding such as comes from some similar clinics. The sphere of interest is centered on the x-ray examination of the newborn, both at term and premature, and the nursing infant. The subject matter is thus more extensive than that of the usual monograph but less than that of the conventional pediatric text. The predominant modality for diagnosis

is plain roentgenography, justified by Dr. Wolf on the ground it is ordinarily the only available technic and that extensive contrast procedures are usually not feasible in infants, while studies requiring large exposures are somewhat dangerous in the newborn.

The book is divided into three almost equal parts: I. The Skeleton; II. The Thorax; III. The Abdomen. The strongest feature of Part I is the chapter on the skull and the weakest is that on fractures of the newborn. In Part II, on the thorax, the chapter on congenital heart disease is purely token but probably sufficient for a book of this nature. The best illustrated section is that on mediastinal emphysema. For the abdomen (Part III), the single survey soft-tissue film is considered paramount, and certainly this view suffices for diagnosis or for a proper therapeutic decision in the majority of instances. Of a particular interest are the illustrations on spontaneous pneumoperitoneum. The book is attractively printed on a hard semigloss paper and beautifully illustrated. A general index and bibliography, with a list of standard pediatric roentgen texts, are included.



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ROENTGEN DIAGNOSIS

THE HEAD AND NECK

Some Aspects of Subarachnoid Haemorrhage—A Symposium. I. Clinical and Surgical Aspects of Ruptured Intracranial Aneurysms. Wylie McKissock. *Brit. J. Radiol.* **32**: 79-83, February 1959. (St. George's Hospital, London, S. W. 20, England)

Of 2,174 cerebrovascular accidents (1940-1957 inclusive), 1,013 were due to ruptured aneurysms, 253 to ruptured angioma, and 363 to unexplained subarachnoid hemorrhage. Subarachnoid hemorrhage is a physical sign established by lumbar puncture and, prior to treatment, the pathological cause of the bleeding must be demonstrated. Investigation begins with compression of each carotid separately for a period of ten minutes. This test establishes the patient's tolerance to ligation of the common carotid in case such a procedure is required. Carotid compression is applied prior to angiography since the latter may cause tenderness and/or hematoma formation in the neck. Cerebral angiography should include such exposures as are necessary to demonstrate the lesion completely. Oblique views are particularly important in aneurysms of the anterior cerebral/anterior communicating complex. Presence or absence of flow of contrast material across the circle of Willis is determined by further injections, with compression of the opposite carotid.

Clinical symptoms and signs vary considerably for each aneurysmal site, depending on the direction of the stream of blood at the instant of rupture. The author advocates operation within a few days following the hemorrhage, in contrast to the fourteen days or more usually allowed. He feels that a long delay is detrimental because of the high mortality of recurrent hemorrhage.

Certain surgical principles have been applied to aneurysms in different sites. The results await further study, but some general statements are made: (1) In anterior cerebral/anterior communicating aneurysms, if adequate crossflow is present and the aneurysm fills from one side only, ligation of the feeding anterior cerebral artery is performed. If there is inadequate crossflow, the neck of the aneurysm is ligated. (2) For middle cerebral aneurysm, occlusion of the neck of the aneurysm is the ideal procedure, but is not always possible. (3) In posterior communicating aneurysms, common carotid ligation is performed except in those patients who do not tolerate preliminary compression of the vessel.

Twelve roentgenograms; 1 table.

S. B. HAVESON, M.D.
Los Angeles, Calif.

Some Aspects of Subarachnoid Haemorrhage—A Symposium. II. Intracranial Aneurysms—Pathological Aspects. T. Crawford. *Brit. J. Radiol.* **32**: 84, February 1959. (St. George's Hospital Medical School, London, S. W. 1, England)

Three factors enter into the pathogenesis of cerebral aneurysms—so-called "berry" aneurysms: (1) developmental faults in the muscular coat of the arteries at points of branching and anastomosis; (2) atheromatous plaques coinciding with a point of medial weakness, leading to further weakening at that site; (3) elevated blood pressure, which may produce aneurysms in vessels with only minor defects in the muscular wall.

The muscular coat of the artery ceases abruptly at

the neck of the aneurysm, the elastic lamina may proceed slightly into the body, but the fundus is comprised of an attenuated layer of hyaline fibrotic tissue. The site of rupture in 163 aneurysms was fundal in 105 (64 per cent), lateral in 17 (10 per cent), cervical in 3 (2 per cent) and undetermined in 38 (24 per cent). Leakage as opposed to rupture is uncommon.

Cerebral aneurysms occur more frequently in an asymmetrical circle of Willis. They are often associated with congenital cystic disease of the kidneys.

S. B. HAVESON, M.D.
Los Angeles, Calif.

Some Aspects of Subarachnoid Haemorrhage—A Symposium. III. The Accuracy of Radiology in Demonstrating Ruptured Intracranial Aneurysms. L. V. Perrett and J. W. D. Bull. *Brit. J. Radiol.* **32**: 85-92, February 1959. (St. George's Hospital, London, S. W. 20, England)

The accuracy of angiography in diagnosis of intracranial aneurysms causing subarachnoid hemorrhage was investigated in 219 autopsied cases. Nine patients with vertebral and basilar artery aneurysms with normal carotid arteriograms died before vertebral injections were obtained. Of the remaining 210 cases, 187 (89 per cent) were accurately diagnosed. The causes of diagnostic error in the remaining 23 cases (11 per cent) are divided into five groups. (1) Arterial spasm prevented the demonstration of an aneurysm in 5 instances (2.5 per cent). None of these cases showed evidence of thrombosis at autopsy. (2) "Observer errors" occurred in 6 cases in which review of films showed a visible aneurysm. Originally, the aneurysm was either not seen or was misinterpreted as a vessel loop. (3) Inadequate examination was performed in 4 cases. Films of poor quality accounted for 3 of these and in the other, oblique projections were not obtained. (4) In 4 cases (2 per cent), the arteriograms were normal even in retrospect. The aneurysms were described as "small" in these cases. (5) There were 4 patients in whom an aneurysm diagnosed radiologically was intact at autopsy, and a second aneurysm, not observed, had ruptured.

The potential accuracy of arteriography is approximately 96 per cent if "observer error" is minimized by additional experience, and if adequate projections of the cerebral vessels are obtained. Three standard projections are used (lateral, anteroposterior, and oblique); in difficult cases, reverse oblique, submentovertical, and periorbital views may be necessary. The last two views are particularly useful in demonstrating middle cerebral aneurysms. Thrombosis did not prevent visualization of an aneurysm in any instance in this series.

Nineteen roentgenograms; 1 table.

S. B. HAVESON, M.D.
Los Angeles, Calif.

Cerebral Arteriography—Diagnostic Value in Cerebrovascular Disease. Basdeo Balkissoon, John B. Johnson, Jesse B. Barber, and Clarence S. Greene. *J.A.M.A.* **169**: 676-682, Feb. 14, 1959. (Howard University, Washington 1, D. C.)

Report is made of the authors' experience with 56 patients undergoing 80 cerebral arteriographic studies. Local infiltration anesthesia about the carotid artery

obviates the need of general anesthesia. A standard arterial needle (Cournand 18-gauge) is inserted through the skin and threaded carefully into the common carotid artery, the tip being guided into the internal carotid when possible. A polyethylene tube connects the needle with the injecting syringe. About 10 c.c. of 60 per cent Renografin is rapidly introduced into the artery and films of the cranium are obtained at one-second intervals for eight seconds after injection. With two such injections, anterior and lateral exposures are made, demonstrating the arterial and venous phases of the cerebral circulation. Undesirable side effects occurred in only 9 patients; 7 of these were in the first 28 injections. No lasting adverse complications have been encountered. The procedure has tended to be most helpful in congenital cerebral aneurysm (7 cases), congenital arterial malformation (5 cases), cerebral thrombosis (9 cases), and subdural or intracerebral hematomas (7 cases). Findings in 57 patients examined are presented in a table.

A plea is made by the authors for greater use of cerebral arteriography in clinical medicine, with emphasis on the fact that the procedure is not technically difficult to perform and carries only a low risk.

Ten roentgenograms; 2 tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Vertebral Arteriography by Percutaneous Brachial Artery Catheterisation. F. Pygott and C. F. Hutton. *Brit. J. Radiol.* 32: 114-119, February 1959. (Central Middlesex Hospital, London, N. W. 10, England)

During a six-month period, 12 patients were examined by vertebral arteriography by percutaneous brachial artery catheterization. Six of the cases are described in detail.

Under local anesthesia, the brachial artery is punctured percutaneously with a Seldinger cannula, size PR 160. Damage to the medial nerve is avoided by carefully noting the patient's reaction. Following puncture, the brachial artery is catheterized for a distance of 18 inches from the puncture site, when a slight resistance will be felt. A test injection of 10 c.c. of 35 per cent Hypaque is made. An anteroposterior film of the root of the neck and thoracic inlet on the appropriate side, taken at this point, almost invariably revealed that the catheter tip had been placed near the origin of the vertebral artery, and satisfactory filling of the vessel was obtained on the first attempt. Next, the intracranial branches are studied, following further injections of 15 c.c. of 35 per cent Hypaque for each projection.

In 2 of the reported cases thrombotic lesions of the vertebral artery were demonstrated; 1 showed displacement of the vertebral artery by cervical spine osteophytes, and in 1 there was a large angioma of the neck. In 1 patient injection of 45 per cent Hypaque resulted in transient homonymous hemianopsia. Subsequently, the 45 per cent concentration was reserved for vertebral arteries of small caliber.

The method described is useful in vertebral artery thrombosis and in other diseases of the basilar system when direct puncture has failed. In cases of subarachnoid hemorrhage direct puncture is preferred, since it affords better concentration of medium in the intracranial portion of the basilar system.

Twelve roentgenograms. S. B. HAVESON, M.D.
Los Angeles, Calif.

Tomography of the Temporal Bone with the Polytome. Ole Tarp. *Acta radiol.* 51: 105-116, February 1959. (County Hospital, Copenhagen, Denmark)

The author discusses the advantages of curvilinear tomography in the examination of bones with special reference to the temporal bone. His material comprised 30 normal subjects and 40 patients operated upon for chronic otitis media. Tomography is done with circular or similar symmetrical movements. With the polytome, the roentgen tube and the film travel in curvilinear paths around the axis of rotation in opposite directions. The points in the plane of the axis do not move in the film and therefore become sharply defined.

The great advantage of tomography of the temporal bone is the accurate information afforded concerning the condition of the attic, which is not obtainable by ordinary roentgenography. Active osteitis and, in many cases, cholesteatomata may be revealed by the former procedure, which also allows evaluation of the condition of the ossicles. Tomography also gives definite information as to the antral region.

A comparison of the operative and tomographic findings showed good agreement as to the patho-anatomical details. However, only in cases with more marked bone destruction was it possible to differentiate otitis media in combination with osteitis from otitis media associated with cholesteatoma. Advanced destruction of the attic and ossicles and sharply defined cavities in the antral region are nearly always due to a cholesteatoma; two cavities, however, were filled with granulations. Denudation of the dura was demonstrated only in 1 of 4 cases. A fistula to the lateral semicircular canal was revealed in 2 cases.

Sixteen tomograms; 1 diagram; 2 tables.

THEODORE E. KEATS, M.D.
University of Missouri

Symmetric Familial Cerebral Calcification. H. J. Schafroth. *Schweiz. med. Wchnschr.* 88: 1269-1273, Dec. 13, 1958. (In German) (Inselspital, Bern, Switzerland)

Symmetrical cerebral calcifications are usually found in the basal ganglia and nucleus dentatus. It is believed that in these cases pseudolime, a calcium-free organic colloid, which normally exists only in small quantities, is deposited in considerably greater amounts which undergo calcification. The resulting circulatory disturbances cause various neurological and psychiatric symptoms.

A familial form of symmetric cerebral calcification, with a possible 7 cases in three generations is described. Five cases have been definitely diagnosed, one appeared probable, and the last one was doubtful.

Clinically, oligophrenia, certain psychic disturbances such as those associated with the psycho-organic syndrome, and, particularly, an extrapyramidal symptomatology dominate the picture. Endocrine disturbances, especially chronic hypoparathyroidism, and various neurological diseases may play a role in individual cases.

Eight roentgenograms; 1 table.

HERBERT POLLACK, M.D.
Chicago, Ill.

Lacrimal Air Anomalies. Jesse M. Levitt and Daniel Kravitz. *Arch. Ophth.* 61: 9-13, January 1959. (515 Ocean Ave., Brooklyn 26, N. Y.)

Two cases of lacrimal air anomalies are reported.

The first patient, a 13-year-old girl, complained of inconstant tearing of the right eye, especially when laughing or coughing, of a few years duration. Palpation over the right lacrimal sac area disclosed a tiny compressible, invisible swelling, with crepitation loud enough to be heard a few feet away. On dacryocystography of the affected side, the lacrimal tract was well visualized; the sac was overfilled; and the system was patent. There was delayed emptying from the nasolacrimal duct, traces of the contrast medium being still evident two hours after injection. An unusual finding was a diverticulum with a narrow neck at the lowermost position of the lacrimal sac, and located slightly anterior and lateral to it; the diverticulum retained the medium almost completely after the lacrimal system had emptied. This patient was thought to have two congenital anomalies, one at each end of the lacrimal tract: valvular insufficiency and a cystic diverticulum of the sac. Dacryocystorhinostomy was advised, but was postponed because it was felt that the symptoms were not sufficiently distressing.

The second patient, a 36-year-old woman, had had tearing for three months and when she blew her nose fluid, bubbling like soda water, came into her left eye. There was no visible swelling of the lacrimal sac. Loud crepitations were occasionally heard on palpation of the sac. Dacryocystography of both sides showed the lacrimal tracts well visualized and patent. The right side was normal. On the left there was residual contrast medium in the tract after forty-five minutes, with marked distention of the sac and nasolacrimal duct. This patient had incompetency of the valvular mechanism of the nasolacrimal duct, permitting air to be blown directly into the eye. In addition, there was an element of infection from the nasal secretions. The patient was cautioned to blow her nose gently, one nostril at a time, while pressing firmly on the lacrimal sac area.

Six roentgenograms; 1 photograph.

THE CHEST

An Accessory Lung Communicating with the Bronchial Tree. H. Lüdeke and M. Pöschl. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 548-551, November 1958. (In German) (M. P., Universitätsklinik, Munich, Germany)

The authors report a case of accessory lung, proved at operation, and shown to communicate with the bronchial system of the right upper lobe by means of a saecular dilated bronchus. The patient, a 27-year-old woman, had experienced bouts of pneumonia recurring over a period of eight years. Roentgenographically, a thick-walled cavity surrounded by sharply demarcated shadows was demonstrated in the left lung. At surgery a tumor 4 to 5 cm. in diameter was removed. This was shown microscopically to be composed of lung tissue poorly aerated by reason of its connection with an ectatic bronchus.

An accessory lung arises from the foregut very early in the embryonic life. Only rarely is there a connection with the bronchial tree (sequestered lung). When intrathoracic, the accessory lung tends to be on the left side, dorsal and basal in location, and almost invariably extrapleural, although sunk into the true lung. The thoracic, intercostal, renal, or one of the phrenic arteries may supply it and it may be drained by the hemi-

azygos, portal, or suprarenal veins. Clinically, most cases are silent.

Three roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

The Origin and Diagnosis of Alveolar-Cell Carcinoma of the Lung (Pulmonary Adenomatosis). R. Pohl. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 527-533, November 1958. (In German) (Lange Gasse 63, Vienna 8, Austria)

A condition originally termed pulmonary adenomatosis, by Melassez in 1876, has since been reported under such designations as cystopapillary lung tumor, adenomatous pneumonia, and alveolar-cell carcinoma. The disease tends to afflict young adults, particularly females, is induced by no known poison or organism, runs a comparatively rapid course, and may be suspected roentgenologically. Although a virus causes a similar ailment in South African sheep, such an origin in man remains unproved.

Histologically the tumor consists of cylindrical cells filling and lining the alveoli without destroying them and with no evidence of squamous metaplasia. Multicentricity is such a common feature that comparison has been made to the multiple carcinomas which accompany intestinal polyposis; in fact, the similarity may be real and the disease the pulmonary equivalent of the intestinal disorder. Once the tumor has started in one or more air sacs, it continues to spread alveolarly. From one air sacculle to the next the entire lung interior becomes coated with these surface metastases. In addition, small blocks of cells may become dislodged, resulting in a bronchial spread.

Modern awareness of the disease and present-day roentgen technics now permit consideration of the diagnosis in the living subject. The case of a 42-year-old female with bilateral pulmonary infiltrates, abundant sputum, and severe dyspnea is detailed. The diagnosis of alveolar-cell carcinoma was made clinically after exclusion of pulmonary metastases from a pancreatic tumor, disseminated tuberculosis, sarcoidosis, mycotic lung disease, pneumoconiosis, and Hodgkin's disease. Autopsy demonstrated pulmonary adenomatosis with lymph-node metastases. In a second case, in a woman of seventy-six, a clinical diagnosis was also made. Here again the gross autopsy report confirmed the impression of alveolar-cell carcinoma, although microscopic study of the tissues showed a widespread necrotizing pneumonia not associated with any tumor.

In conclusion, the author states that alveolar-cell carcinoma is a specific, relatively rare tumor, not related at all to bronchogenic carcinoma, not metastatic other than from the lung, and difficult but not impossible to diagnose in the living. One must still allow for an element of diagnostic error in this disease.

Three roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

The Condition of the Pulmonary Vessels in Bronchial Carcinoma: An Electrocardiographic Investigation. J. Lissner. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 534-544, November 1958. (In German) (Medizinische Universitätsklinik, Frankfurt a. M., Germany)

Electrocardiography for the study of variations in vascular density in the central and peripheral lung fields

has the advantage over angiography that no injection is required.

The author studied with the electrokymograph 80 patients with lung tumor and 200 normal controls. Recordings were made from a photomultiplier RCA electron tube No. 931A with simultaneous recordings of the electrocardiograms and of the carotid pulse. There were 6 recordings for each chest, 3 on each side, covering upper, middle, and lower lung fields. In the normal subjects all 6 curves were of the arterial type, very similar to the pulsations of the pulmonary arteries but with a somewhat smaller incisura.

In the presence of lung tumor, the characteristic electrokymographic sign of Marchal was observed. The curves were absent over lung areas supplied by a bronchus or vessel involved by the carcinoma even when no radiological changes were otherwise apparent. Bronchial cancer produced a lack of vascular variations in density in the lung field peripheral to the carcinoma, indicating a tremendously diminished blood supply to that portion of the lung. This sign is not specific, however, as a similar decrease in blood flow may result from emphysema, atelectasis (regardless of cause), or the collapsed lung of a pneumothorax. In spite of its non-specificity, it is nevertheless an aid, with other radiologic investigations, in tumor diagnosis.

Results of 10 case studies are reported in detail.

Seventeen figures, including 9 roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

Pulmonary Tuberculosis Associated with Carcinoma of the Lung. A. J. Christoforidis and R. H. Browning. *Arch. Int. Med.* 103: 231-238, February 1959. (Ohio Tuberculosis Hospital, Ohio State University Campus, Columbus 10, Ohio)

Coexisting pulmonary tuberculosis and bronchogenic carcinoma are being encountered with increasing frequency. This is due to two factors: (1) The distribution of active pulmonary tuberculosis is moving constantly toward the older age groups. (2) Carcinoma of the lung is increasing in frequency, now constituting at least 10 per cent of all malignant tumors. Ten illustrative cases are reported.

In 6 cases the first manifestation of carcinoma was unilateral hilar lymph node enlargement. This is in accord with the findings of Rigler, *et al.* (*Radiology* 59: 683, 1952), who pointed out that this very important sign is commonly overlooked and is usually present before symptoms appear. The problem is not one of diagnosis but of detection. To measure the transverse diameter of the hilus, the authors accept as the medial measuring location a point on a vertical midthoracic line bisecting the horizontal transthoracic diameter at the aortic arch and at the level of the diaphragm. The lateral border of the hilus is considered as the hilar margin farthest from the midline but not including the first branching of each pulmonary artery. Prerequisite for an accurate measurement on the postero-anterior roentgenogram is positioning of the patient without significant rotation. To ascertain that the hilar enlargement is actual and not due to projection of a pulmonary lesion at this level, as from the superior segment of the lower lobe, a lateral view is needed.

Obliteration of the medial aspect of the pulmonary artery does not increase the transverse diameter of the hilus but gives an "appearance of solidity," as Rigler points out. An enlarging hilus, demonstrated roentgen-

ographically, is significant, no matter what the absolute transverse diameter may be. It is abnormal for a hilus which measured 4.0 cm. to become 6.0 cm. in diameter, in spite of the fact that for another person a 6.0 cm. hilus may be normal.

Conditions other than carcinoma can produce unilateral adenopathy, although these conditions are not frequent in older age groups. If hilar adenopathy is detected, then other more accurate diagnostic procedures, such as laminagraphy, bronchography, bronchoscopy, and cytologic studies, may be carried out. A hilus greater than 5.5 cm. in diameter is suspicious and one above 7.0 cm. should be considered abnormal and further evaluated. A difference of more than 2.0 cm. between the two hili should also be considered abnormal.

In some instances where hilar adenopathy is not present, the first manifestation of carcinoma may be the appearance of a pulmonary infiltrate near to or remote from the tuberculous lesions. Such a lesion within the normally air-containing lung parenchyma is easy to detect. This may persist or increase in spite of the fact that the tuberculosis is improving, cavities are closing, and the sputum is converted to a "negative" status. This should suggest the possibility of a second disease, and cancer should be the first consideration.

The clinical picture of the patient must be weighed also. A unilateral wheeze which the patient did not have originally is significant and indicates a partial bronchial occlusion. Unexpected hemoptysis and blood-streaked sputum require investigation. Weight loss, anemia, and other symptoms which occur while the tuberculous process is improving roentgenographically will arouse the alert physician to the possibility of bronchogenic carcinoma.

Fourteen roentgenograms.

Bronchogenic Carcinoma Arising in a Lung Cyst. Report of a Case. S. Brünner. *Acta radiol.* 51: 117-120, February 1959. (University of Copenhagen, Copenhagen, Denmark)

The author reports the development of bronchogenic carcinoma in a pulmonary cyst. The usual complications of a lung cyst are infection and spontaneous pneumothorax. The development of a carcinoma is a rare occurrence.

The patient was a 56-year-old male with a long history of bronchial asthma and emphysema. The cyst, located in the right upper lobe, had been discovered two years prior to admission to the hospital. One year later it had increased in size and was still well defined, but a small zone of soft-tissue density was seen at the interior surface of the lateral wall. There was a small amount of fluid in the lumen. A further marked increase in size occurred in the next eight months and there was thickening of the wall. On admission, the cyst was still fairly well defined from the surroundings by a narrow dense zone. Lobectomy was performed and the patient died two days following operation. Histologic examination showed carcinoma arising from the lateral cyst wall.

The author feels that, since infection is likely to occur sooner or later in most pulmonary cysts, surgical intervention should be considered as a matter of principle in all cases in which local and general conditions permit.

Four roentgenograms.

THEODORE E. KEATS, M.D.
University of Missouri

Cystic Lung Lesions from Metastatic Sarcoma. Neil E. Crow and Byron G. Brogdon. *Am. J. Roentgenol.* 81: 303-304, February 1959. (USAF Hospital, Lackland AFB, Texas)

The authors report a single case of metastatic pulmonary sarcoma in a 20-year-old white male who had undergone an upper thigh amputation for osteogenic sarcoma of the distal femur. Two or three months following operation the patient experienced sudden left lower chest pain of pleuritic nature. A roentgenogram at this time was normal, but within another month several thin-walled cystic lesions, some with fluid levels, were demonstrable in the lower lobes of both lungs. In the ensuing two months new cystic lesions appeared, many of which were surrounded by infiltration. Death occurred six months after the original operation.

This case is of interest because of the initial cystic manifestation of the pulmonary metastases, although subsequently obvious metastatic tumor developed. The authors believe that it may explain the "spontaneous" pneumothorax which has been reported in association with metastatic sarcoma and agree with the contention of Lodmell and Capps (*Radiology* 52: 88, 1949) that rupture of such tumor-produced cysts or blebs may be responsible for the pneumothorax in such cases.

Four roentgenograms. RICHARD A. ELMER, M.D.
Atlanta, Ga.

Pulmonary Infiltration and Fibrosis of Unknown Etiology. The Risk of Developing Active Pulmonary Tuberculosis. John F. Chace, S. David Rockoff, and Louis P. Hellman. *Arch. Int. Med.* 102: 367-374, September 1958. (Department of the Navy, Bureau of Medicine and Surgery, Washington 25, D. C.)

In order to assess accurately the risk of development of active pulmonary tuberculosis in persons with predominantly noncalcified pulmonary lesions "proved" by clinical study to be "stable" or "inactive," 268 Naval and Marine Corps personnel who were hospitalized and returned to duty in 1951 with a diagnosis of pulmonary infiltration or fibrosis of unknown etiology were followed for three years, 1952-1954. A review of the roentgenograms in these cases revealed pulmonary lesions which were localized and contained little or no calcification. In general, no difference was apparent radiologically between those lesions diagnosed as "infiltration, pulmonary, cause undetermined" and "fibrosis, pulmonary, cause undetermined." Four illustrative cases are presented. The similarity of the results of clinical investigation and the likeness of the radiologic appearance of the lesions suggested that the separation of such cases into diagnoses of "fibrosis" and "infiltration" was an artificial one, and all cases were therefore studied as a single group.

In 16 of the 268 cases active pulmonary tuberculosis developed. In every instance, the active disease involved that region of the lung which had been clinically investigated during the 1951 hospitalization. Two of these cases are reported.

A control group consisting of 493 Naval and Marine personnel who were hospitalized and returned to duty in 1951 with a diagnosis of hemorrhoids were also followed for three years, 1952-1954. In no one of this group did active pulmonary tuberculosis develop.

Analysis of the two groups indicated that the risk of development of active pulmonary tuberculosis in personnel with "stable" or "inactive," predominantly

noncalcified pulmonary lesions was markedly greater than in the comparable control group.

Application of the tuberculosis attack rate of the study group to the U. S. Navy as a whole during the years of the investigation showed the observed number of cases of active pulmonary tuberculosis (1,206) to be less than 2 per cent of the number expected (66,590).

The development of tuberculosis in the study was compared to the relapse rate of selected U. S. Army cases of active pulmonary tuberculosis which had been treated to the arrested stage and returned to duty and was found, in general, to be not very different.

It is concluded that persons in the U. S. Navy, shown by means of present diagnostic methods to have either pulmonary infiltration or fibrosis of unknown etiology, are more likely to have or to develop active pulmonary tuberculosis than is now generally appreciated.

Nine roentgenograms; 4 tables.

Pulmonary Manifestations in Collagen Diseases.

Charles M. Nice, Jr., A. N. K. Menon, and Leo G. Rigler. *Am. J. Roentgenol.* 81: 264-279, February 1959. (C. M. N., Tulane University School of Medicine, New Orleans 12, La.)

This study of collagen diseases is based on a review of case records, pathologic data, and roentgenograms of 109 patients seen over a fifteen-year period. Polyarteritis nodosa, disseminated lupus erythematosus, scleroderma, dermatomyositis, and rheumatic pneumonitis are included. Cases diagnosed by autopsy or biopsy are considered proved. Other cases were diagnosed clinically.

Significant pathologic lesions were found in the lungs, pleura, or heart in 28 of 34 autopsies in this series. Roentgen signs were demonstrated in these organs in approximately two-thirds of the entire series of 109 patients, including those still living. From this it would seem that, if periodic roentgen examinations were done in all cases until death, signs would appear in the chest during some phase of the disease in over 80 per cent of patients.

In about one-third of this series of 109 patients the roentgenograms of the chest probably did not contribute to the diagnosis at any time. In another one-third, one or two abnormalities in the chest appeared at some phase of the disease process as confirmatory findings which could be considered of help in following the progress of the disease. In the remaining third there was a combination or sequence of roentgen findings which should lead one to suspect a collagen disorder. In this group, with the aid of laboratory findings, roentgenographic changes will contribute to the differentiation of the various types of collagen diseases in about one-fifth of the patients.

Nonspecific cardiac enlargement, pneumonitis and pleural effusion occur with sufficient frequency in all five of these collagen diseases so that they are of little differential diagnostic value. Pericardial involvement associated with pleural effusion, or the presence of atelectasis and pneumonitis, suggests the diagnosis of disseminated lupus erythematosus or rheumatic pneumonitis. Hilar vascular prominence in combination with nodular pulmonary lesions is indicative of polyarteritis nodosa. Interstitial pulmonary fibrosis is common to both scleroderma and dermatomyositis but the presence of small cyst-like shadows makes scleroderma more likely. A dilated aperistaltic esophagus may also be seen in scleroderma.

Selected case reports illustrate how an analysis of various combinations of nonspecific roentgen signs may lead one to suspect a collagen disease and occasionally make a specific diagnosis.

Twenty-three roentgenograms; 3 tables.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Pulmonary Paragonimiasis. An Evaluation of Roentgen Findings in 38 Positive Sputum Patients in an Endemic Area in Thailand. Romsai Suwanik and Chamlong Harinsuta. *Am. J. Roentgenol.* **81**: 236-244, February 1959. (Siriraj Hospital and Medical School, Dhonburi, Thailand)

Roentgenograms of 38 patients with sputa positive for ova of *P. westermani* from an endemic area of Thailand revealed the presence of lung flukes in 95 per cent. The roentgen findings were of four types: (1) characteristic ring shadows; (2) opacities with poorly defined borders; (3) linear infiltrations; (4) pleural thickening.

The ring shadows represent thin-walled cysts with a crescent-shaped opacity along one side, "resembling a solar eclipse during the corona stage." Usually they were multiple and aggregated, but occasionally a solitary lesion was found. The range in size was from 6 mm. to 4 or 5 cm. in diameter. In some obscure cases, the smaller ring shadows were demonstrated only by laminagraphy. These characteristic shadows were observed in 20 of the 36 positive cases and in an additional 11 cases were present in association with some of the other manifestations of the disease. Frequently associated with the ring shadows was the demonstration of irregular tracts or burrows communicating with the adjacent cysts. On laminagrams the lumen of these tracts measured as much as 5 mm. in diameter, compared to the 2 or 3 mm. for the corresponding medium and small bronchi.

Opacities with poorly defined borders were the chief finding in 9 patients and were demonstrated in an additional 9 patients with other major roentgen manifestations. These appeared as a mottling or as nodular shadows of 3 to 4 cm. diameter, usually in the lower and peripheral lung fields. In general, the roentgen picture was suggestive of pneumonitis as found in Loeffler's syndrome, gnathostomiasis, or ascariasis.

Linear infiltration was the chief manifestation in only 3 patients and pleural thickening in 4. Calcifications were noted in 4 patients.

Eleven roentgenograms; 4 tables.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

The Problem of Absorption of Liquids from the Lung—Particularly Bronchographic Contrast Material. M. Roth. *Fortschr. a. d. Geb. d. Röntgenstrahlen* **89**: 517-527, November 1958. (In German) (Pekařská 53, Brno, Czechoslovakia)

In a search for a nonirritating contrast material for bronchography, the author tried antigen-free plasma as a vehicle for 50 per cent Ultraren Na (known in America as Uroselectan B or Neo-Iopax). Antigen-free plasma is theoretically nonirritating and should be satisfactorily absorbed because it is digestible by the ordinary body enzymes. Three grams of dried plasma were added to 6 c.c. of the medium and experimental studies were made in animals. The phenomenon of osmotic pulmonary edema was immediately encountered and further investigations were directed accordingly.

Hypotonic solutions introduced into a bronchus quickly reach the pulmonary alveoli and, other things being equal, 90 per cent of the material is absorbed in thirty minutes, with no sequelae. Isotonic solutions also travel to the periphery, with absorption of 35 per cent in the same period. With hypertonic solutions, on the other hand, absorption is very slow. Within fifteen minutes of the introduction of a hypertonic salt solution there is a marked increase in the volume of fluid in the lung (164 per cent), because the body fluids immediately act to render the hypertonic solution isotonic. In this process the alveolar membrane serves as a passive physical membrane in the interchange of the fluid. The increase in intra-alveolar and intrabronchial fluid volume produces what is known as osmotic pulmonary edema, which can be rapidly fatal.

In his study of this phenomenon the author injected 2.5 c.c. of a 50 per cent aqueous Neo-Iopax solution into a guinea-pig lung. There was an immediate metallic density outlining the bronchi, such as one would expect from the medium. Two minutes later this density began to fade and a diffuse homogeneous increase in lung opacity developed, reaching a maximum in five minutes. The pulmonary infiltration persisted for approximately six hours and then gradually cleared so that the lung was negative radiographically in twenty hours. The same test was repeated with 2.5 c.c. of 5 per cent salt solution containing no Neo-Iopax. While there was no immediate increase in density, particularly none of a metallic nature, in two minutes a diffuse opacity developed, very similar to that which was superimposed upon the metallic density in the original guinea-pig study. This increased rapidly over the next ten or fifteen minutes, with a pulmonary infiltrate persisting for six hours. Twenty hours later the lung was again clear.

The author concludes that the late densities in the lung following the use of aqueous contrast material are due to osmotic edema and are thus the equivalent of a pneumonic infiltrate. He further believes that at the present time the use of non-antigenic plasma is not warranted and is, in fact, dangerous. The plasma is not a substitute for carboxymethylcellulose.

Twenty-three roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

THE HEART AND BLOOD VESSELS

Rheumatic Heart Disease Associated with Atrial Septal Defect: Clinical and Pathologic Study of 12 Cases of Lutembacher's Syndrome. J. Espino-Vela. *Am. Heart J.* **57**: 185-202, February 1959. (Department of Congenital Heart Diseases, National Institute of Cardiology, Mexico, D. F.)

Lutembacher's syndrome is a relatively rare condition in which mitral stenosis is associated with atrial septal defect. In the cases reported in the present paper the valve lesions were multiple, and rheumatic heart disease associated with atrial septal defect seems a more appropriate designation. For a diagnosis of Lutembacher's syndrome the auricular defect must be a permanent one, with a free flow of blood (not merely a probe-patent foramen ovale). The most prominent feature is a chronic arteriovenous shunt leading to right heart hypertrophy and pulmonary hypertension. Embryologically the condition appears to be a result of resorption of the septum primum with poor develop-

ment of the septum secundum. Twelve cases are reviewed in which the diagnosis was established either at operation or at autopsy.

X-ray examination in this series was compatible with rheumatic heart disease in each instance. The pulmonary artery segment was usually prominent; in other cases it formed a large convex contour continuous with the arc of the right ventricle, due probably to clockwise rotation of the heart. The pulmonary branches were usually large and opaque, with increased pulsations, which suggested the diagnosis of atrial septal defect. The left auricle was not invariably enlarged, but the right auricle was always very large. The right ventricle was also enlarged to a greater degree than the left. The aorta was usually normal. Marked cardiomegaly was common.

All of the cases were pathologically proved examples of rheumatic heart disease. The association of the two entities elevates the pulmonary pressure. This results in cyanosis, which clinically suggested the diagnosis of atrial septal defect in 5 of the cases.

Twelve roentgenograms; 5 photographs; 4 electrocardiograms; 3 tables. ROGER M. STOLL, M.D.

New York, N. Y.

Beriberi Heart Disease. Reverdy H. Jones, Jr. *Circulation* 19: 275-283, February 1959. (Lewis-Gale Hospital, Roanoke, Va.)

The classical picture of beriberi heart disease is one of right heart failure, rapid circulation time, peripheral vasodilatation, venous engorgement, frequent syncope and shock, and nonspecific cardiac enlargement. This syndrome is seen almost exclusively in the Orient in patients with long standing gross deficiency of vitamin B₁ and responds to administration of thiamine. Usually there are also polyneuritis and pellagra and no other apparent cause of heart failure.

In the Occidental cases rapid circulation is a less common feature and the diagnosis is frequently not entertained. A chest film usually reveals cardiac enlargement with prominence of both the left and right ventricles and pulmonary congestion. On fluoroscopy, cardiac pulsations can be readily distinguished and the cardiac shadow may be differentiated from pericardial effusion. Pleural effusion is not uncommon.

Two cases are reported, one in an alcoholic with dietary deficiency of vitamin B₁ as the sole etiology. The other patient had rheumatic mitral valvular heart disease but did not respond to digitalization and diuretics until thiamine was added.

The author believes that vitamin B₁ deficiency should be considered in any case of cardiac failure refractory to ordinary measures or where a deficient dietary history is obtained. Thiamine should be given as soon as possible, when indicated, since it may be life-saving.

Eight roentgenograms; 3 electrocardiograms; 1 table. ZAC F. ENDRESS, M.D.

Pontiac, Mich.

Postoperative Myxedema Cardiopathy: an Unusual Instance Which Developed in the Immediate Postoperative Period. Case Report and Review of the Literature. F. G. Hoffman. *Am. Heart J.* 57: 463-469, March 1959. (VA Hospital, Columbia, S. C.)

The basis for the enlarged cardiac silhouette in myxedema has been a subject of controversy. Some authorities feel that it is due to pericardial effusion, and others

that it is attributable to involvement of the entire myocardium. White (Heart Disease. New York, Macmillan Co., 4th ed., 1951) thinks that three factors are involved: (1) dilatation, (2) increase in the "bulk" of the heart muscle, (3) pericardial effusion. Congestive failure is usually not seen in this condition.

A case is reported in which the cardiac silhouette was found to be enlarged ten days following thyroidectomy in an apparently euthyroid patient. On admission she was found to have an enlarged thyroid, and a chest film indicated that the heart was not enlarged. Thyroidectomy was performed. Two weeks later the patient complained of chest pain and abdominal discomfort. Roentgenography now demonstrated a definite increase in the transverse diameter of the heart. Cardiac fluoroscopy showed a globular cardiac silhouette with decreased pulsations. Treatment with desiccated thyroid was instituted, and a decrease in the size of the heart was seen after nineteen days of therapy. One week later the heart was normal in size.

As a rule, hypothyroidism will not occur postoperatively before the second or third month. Usually in these cases there is underlying heart disease.

Three roentgenograms, with accompanying electrocardiograms. ROGER M. STOLL, M.D.

New York, N. Y.

A Roentgenkymographic Sign of the Gastrocardiac Syndrome of Römheld. H. Grasser. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 558-560, November 1958. (In German) (Ungerstr. 84/0, Munich 23, Germany)

Every radiologist has observed patients with pyknic habitus, large gastric air bubble, distended splenic flexure, elevated diaphragm, and a transverse position of the heart, but no cardiac symptoms. In such cases the evidence is insufficient for the exact diagnosis of Römheld's gastrocardiac syndrome.

Although Römheld stands alone in regarding his syndrome as an entity, it is well known that on occasion gaseous distention of the abdomen can produce cardiac symptoms, an observation dating from the early days of pneumoperitoneum. If the diaphragm is pushed too high, the heart and lungs have too little room and symptoms may result. Under these circumstances, according to the author, Römheld's gastrocardiac syndrome may result. To support this view, he presents roentgenkymograms showing a peculiarity of pulsation in the left border of the heart. This he designates the "drum symptom" (*Paukensymptom*), a term derived from the resemblance of the kymographic curves, when viewed from the side, to a snare drum.

Five kymograms. WILLIAM F. WANGNER, M.D.

Royal Oak, Mich.

Congenital Aneurysms of the Coronary Arteries with Report of a Case. Ira Gore, John Smith, and Robert Clancy. *Circulation* 19: 221-227, February 1959. (VA Hospital, West Roxbury, Mass.)

A single case of congenital coronary artery aneurysm is reported, having the distinction of being the first of the 21 in the literature to have been seen (but not recognized) antemortem. A lateral Bucky film of the chest made a year before death had shown an ovoid area of calcification anteriorly near the base of the pulmonary conus. It was interpreted as atypical pericardial calcification.

The patient had experienced anginal symptoms for two years before the final coronary thrombosis at the

age of twenty-six. At autopsy both branches of the left and the trunk of the right coronary artery showed diffuse aneurysmal dilatation, with the lumen nearly obliterated by laminated clot.

One roentgenogram; 1 photomicrograph; 2 photographs; 2 tables.

ZAC F. ENDRESS, M.D.
Pontiac, Mich.

Hypoplasia of the Aorta: Report of a Case. Kalevi Pyörälä, Per-Erik Heikel, and Pentti I. Halonen. *Am. Heart J.* 57: 289-297, February 1959. (Hospital of the Wihuri Research Institute, Helsinki, Finland)

Hypoplasia of the aorta is an anomaly in which the arterial vessels in the greater circulation remain abnormally small. It is not unusual to find this condition as a coexisting anomaly in congenital cardiovascular disease. It is often associated with coarctation of the aorta. Left ventricular hypertrophy is the most frequent autopsy finding. Occasionally right ventricular hypertrophy is observed. Angiocardiology and aortography are the most exact means of establishing the diagnosis.

The authors report the case of a six-year-old boy in whom the diagnosis was made by catheterization and angiocardiology. The child was weak, and mental development was retarded. X-ray examination showed absence of the aortic knob. Aortic coarctation was suspected because of a higher systolic pressure in the arms than in the legs. Angiocardiology was performed, and the left ventricle was found to be dilated. The whole aorta was hypoplastic, its diameter being only 8 mm.

Autopsy findings in these cases suggest that hypoplasia of the aorta causes left ventricular strain with resulting failure, which is then followed by passive pulmonary hypertension and right ventricular enlargement. The diagnosis should be considered in cases of cardiac failure in young people without other apparent cause.

Three roentgenograms; 1 phonocardiogram; 1 electrocardiogram.

ROGER M. STOLL, M.D.
New York, N. Y.

Contrast Visualization of the Venae Cavae in Management of Lymphoma. Billy P. Sammons, Ronald R. Lund, William O. Pischnotte, and Charles Gartenlaub. *J.A.M.A.* 169: 704-706, Feb. 14, 1959. (U. S. Naval Hospital, St. Albans, N. Y.)

For demonstration of the inferior vena cava a 17-gauge needle is inserted percutaneously into the right femoral vein and 30 c.c. of a 50 per cent solution of Hypaque is injected rapidly. With the first injection a transabdominal lateral film of the abdomen is obtained. A second similar injection is followed by anteroposterior filming of the abdomen, which demonstrates the inferior vena cava as well as the urinary tracts. For superior vena caval visualization, 30 c.c. of 50 per cent Hypaque is injected as rapidly as possible into an antecubital vein through an 18-gauge needle. A single supine film of the chest is exposed near the end of the injection by a Bucky grid technic. A second film, six seconds later, allows further evaluation of obstruction and/or collateral circulation. Pyelography is also carried out as part of the procedure. The authors report no significant morbidity in over 200 examinations thus performed.

Forty cases of malignant lymphoma have been investigated by these technics in addition to the usual

routine studies. In one-fourth of the cases unexpected retroperitoneal involvement was demonstrable. In other instances a more exact evaluation of the extent of known intrathoracic or intra-abdominal disease was obtained, allowing a more enlightened therapeutic approach. A further use of the technic is in evaluation of response to treatment. Occasionally cavograms will disclose accurately early recurrence of disease or involvement of new areas in patients already under treatment.

Ten small illustrative roentgenograms are included.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

High Pressure Patent Ductus Arteriosus. A Report of Three Cases. Jerome Harold Kay, Robert M. Anderson, John E. Meihaus, and Reuben Lewis. *California Med.* 90: 164-166, February 1959. (2212 W. Third St., Los Angeles 57, Calif.)

In some patients with patent ductus arteriosus a very pronounced pulmonary hypertension is present, with pressures in the pulmonary circulation as high, or nearly as high, as in the systemic circulation. In such cases differential diagnosis with exact identification of the lesion may not be readily accomplished so that cardiac catheterization becomes necessary. At times it may be impossible even with catheterization to distinguish precisely between ventricular septal defect, aortic septal defect, and patent ductus arteriosus. In 1 of 3 cases recorded here, it was necessary to resort to retrograde aortography and rapid serial filming for contrast demonstration of the patent ductus.

Three case histories are presented in moderate detail. In each instance a large-caliber patent ductus was successfully ligated, with a good result.

Three surgical diagrams.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Roentgen Diagnosis of Anomalous Pulmonary Venous Drainage of Right Lung into Inferior Vena Cava. Report of Three New Cases. Israel Steinberg. *Am. J. Roentgenol.* 81: 280-289, February 1959. (New York Hospital, New York, N. Y.)

The purpose of this paper is to report 3 new cases of anomalous pulmonary venous drainage of the right lung into the inferior vena cava, each with an unusual feature; to review 9 cases studied by the author; and to re-emphasize the importance of roentgenography in diagnosis.

Associated with the anomalous pulmonary venous drainage in the first patient, a fifty-five-year-old woman, was a huge left diaphragmatic hernia causing dyspnea. Angiocardiology revealed an anomalous right pulmonary vein entering the inferior vena cava. Cardiac catheterization showed an intact atrial septum. The hernia was surgically repaired and symptoms disappeared.

The second patient, a ten-year-old girl, had an unusually high immobile right diaphragm and coarctation of the aorta. Angiocardiology, performed in order to visualize aortic coarctation, revealed an unsuspected pulmonary venous channel draining into the inferior vena cava. Exploratory thoracotomy confirmed the roentgen findings.

The third patient, an asymptomatic fifty-year-old man, was found to have roentgen features characteristic of the anomaly. However, electrocardiography

demonstrated overloading of the right ventricle, an enlarged pulmonary artery, and a plethoric left lung that suggested an atrial septal defect. Serial angiocardiology disclosed enlargement and slight dextrorotation of the right atrium, ventricle, and pulmonary artery. The right pulmonary artery was smaller than the left, with crowding and distortion of the pulmonary arterial circulation of the right lower lung. When the left heart structures were visualized a large multiple branching pulmonary vein was seen along the right cardiac border, proceeding into the inferior vena cava.

When dyspnea and bronchopulmonary disease are present in patients with anomalous drainage of the right lung into the inferior vena cava, abdominal aortic branches inserting into the right lower lobe should be suspected. Right pneumonectomy in such cases has been curative.

Conventional frontal roentgenograms of the chest often disclose the characteristic features of anomalous pulmonary venous drainage of the right lung into the inferior vena cava. This is manifest by a characteristic multiple branching vessel increasing in breadth from above downward to merge into a broad crescentic channel adjacent to the right cardiac border. Often the right lung is hypoplastic. In contrast the left lung appears well vascularized, even plethoric, and may be larger than its mate. The right atrium, because of increased blood flow, is unduly prominent; it may extend well into the right hemithorax as a result of displacement of the heart by the enlarged left lung.

Asymptomatic patients with partial anomalous drainage of the right lung into the inferior vena cava do not require treatment, this type of anomaly being compatible with long life. However, patients with dyspnea, recurrent pulmonary infections, and plethora of the lungs may have an associated cardiac lesion, such as an atrial septal defect, that requires repair.

Angiocardiology establishes the definitive diagnosis by clearly demonstrating the anomalous right pulmonary vein plunging below the diaphragm at the cardiohepatic angle. Re-opacification of the right atrium, ventricle, and pulmonary arterial system confirms the existence of the left-right cardiac shunt.

Eleven roentgenograms.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

Varicosity of the Pulmonary Vein. B. Gimes and F. Horváth. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 545-548, November 1958. (In German) (Röntgenklinik der medizinischen Universität Budapest, Hungary)

Varicosity of the pulmonary vein was found in a 34-year-old male with chest pain, referred for tomography to determine the activity of what was thought to be tuberculous infiltration in the left upper lobe. The diagnosis of a varix of the pulmonary vein was made on the basis of the opacities in the routine chest film; tomography showed continuity with the hilus and no evidence of cavitation. There was a decrease in size of the vessel with the Valsalva maneuver, and spot angiography demonstrated filling of the vein with the contrast medium.

Varix of the pulmonary vein is a rare condition, although it was noted at autopsy as early as 1843. It may be accompanied by varices elsewhere in the body. Usually there are no symptoms, but chest pain, hemoptysis, and cyanosis have been reported. Death due

to massive hemorrhage is known to have occurred. Three roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

Old Massive Pulmonary Embolism. H. U. Zollinger and L. Hensler. *Schweiz. med. Wchnschr.* 88: 1227-1233, Dec. 6, 1958. (In German) (Pathologische Institut und medizinische Klinik des Kantonsspitals, St. Gallen, Switzerland)

The authors describe the clinical and anatomical findings of old massive pulmonary embolism as observed clinically in 14 patients, and at autopsy in 68 cases. The first group comprised 9 men and 5 women with an age range of thirty-seven to eighty-five years.

The main clinical symptom is a slowly increasing pulmonary hypertension leading to hypertrophy and finally to insufficiency of the right heart. The radiograph of the chest shows a typical prominence of one or both pulmonary arteries. In differential diagnosis a thrombosis of the pulmonary artery, a congenital heart lesion, an acute pulmonary infarct, bronchogenic carcinoma, and other conditions must be considered.

Clinical signs are present only when the pulmonary blood flow decreases to less than one-third of the normal. The anatomical structure of the occluding masses proves that they are definite embolisms and not primary thrombi. A rather frequent complication, however, is a secondary thrombus formation.

The condition is not rare, affecting elderly patients for the most part. The right pulmonary artery is far more often involved than the left or the main trunk.

The importance of early recognition of an old massive pulmonary embolism is stressed, especially in view of recent experiments undertaken to prove the feasibility of surgical therapy of pulmonary artery disease. An attempt has been made to remove the old embolus or thrombus and even to replace the pulmonary artery by a vascular transplant, in order to prevent development of hypertrophy and insufficiency of the right heart.

Four cases are reported in detail.

Four roentgenograms; 8 photomicrographs; 4 photographs; 1 diagram. HERBERT POLLACK, M.D.
Chicago, Ill.

Angiography in Soft Tissue Hemangiomas. Osborne Bartley and Ingmar Wickbom. *Acta radiol.* 51: 81-94, February 1959. (Sahlgrenska Sjukhuset, Gothenburg, Sweden)

The authors report 8 cases of deeply situated soft-tissue hemangiomas which were examined by angiography. Arteriography was performed, as a rule, by means of a percutaneously inserted polythene catheter, approximately 10 c.c. of Umbradil 35 per cent or Hypaque 45 per cent being injected. In 2 cases in which the tumor was not filled by this technic, injection was made directly into the hemangioma, with the same media in the same amount.

Six of the cases were cavernous or venous hemangiomas and in these the angiographic appearance was considered to be diagnostic. These lesions show wide vascular channels or lakes which are contrast-filled in a late phase and remain so for a considerable time. This does not occur in any tumors other than the cavernous or venous hemangiomas, except possibly in the rare malignant type. Arteriovenous aneurysms may show a similar appearance, but the circulation is more rapid and the afferent and efferent vessels are widened.

In the remaining 2 cases, which histologically were mixed angiomas, the arteriographic appearances were typical, with very small, tightly packed vessels with tortuous feeding arteries, but presumably other tumors rich in capillaries might show a similar picture.

The irregular angio-architecture in malignant soft-tissue tumors is such, as a rule, that these tumors should not be difficult to differentiate from angiomas. In the authors' experience, malignant tumors and inflammatory lesions have not presented the same angiographic picture as the angiomas.

Eighteen roentgenograms; 4 photomicrographs.

THEODORE E. KEATS, M.D.
University of Missouri

Intra-Osseous Venography in Portal Hypertension. Franz P. Lessmann and Robert Schobinger. *Acta radiol.* 51: 95-104, February 1959. (Roswell Park Memorial Institute, Buffalo, N. Y.)

Intra-osseous venography was used in a radiologic study of the collateral venous system in portal hypertension. The procedure was carried out in 25 cases. The contrast material is injected into the medullary cavity of one of the lower ribs on the left and occasionally also on the right side. Approximately 10 c.c. of 50 per cent Hypaque is used, and two or three films are obtained after the injection is completed.

Twelve patients without evidence of liver disease were examined, as well as 5 with a diagnosis of hepatitis, and 8 with a clinical and histologic diagnosis of cirrhosis of the liver.

In subjects without evidence of liver disease, the contrast medium passes from the injection site in the rib through the intercostal vein into the azygos or hemiazygos veins. Occasionally, an adjacent intercostal vein is demonstrated through a subcostal channel. In hepatitis, the findings are similar.

In patients with histologically diagnosed cirrhosis of the liver either with or without radiologic evidence of esophageal varices, the intra-osseous method revealed the vertebral plexus, with delayed filling of the azygos or hemiazygos veins. In addition, a fine network of smaller veins surrounding the intervertebral and intercostal veins was found. In 3 cases, greater vessels were demonstrated in the abdominal cavity, such as the splenic, right gastroepiploic, and left phrenic veins. It was not found possible to demonstrate the submucosal plexus or the paraesophageal trunk of the esophagus.

The results of these examinations do not permit conclusions regarding the diagnostic value of the procedure, but present experience indicates that intra-osseous venography may be an additional implement in the diagnostic evaluation of portal hypertension.

Seven roentgenograms; 1 diagram.

THEODORE E. KEATS, M.D.
University of Missouri

THE DIGESTIVE SYSTEM

Dynamic Changes of the Varicose Esophagus. A Cineradiographic Study with the Image Intensifier. L. Ciarpaglini and G. Iannaccone. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 551-557, November 1958. (In German) (Istituto di radiologia dell'Università-Policlinico, Rome, Italy)

The moth-eaten irregular appearance of the varicose esophagus can readily be demonstrated on roentgen

examination with barium sulfate as a contrast material. Fluoroscopically one can see the variation in the appearance of the varices under the influence of tonic and atonic phases of peristalsis. Motion pictures permit the recording of these events and their study at leisure.

In 11 cases in which esophageal varices had been diagnosed from conventional films, cineradiographic views were obtained, frequently illustrating phases difficult to observe otherwise. Incomplete esophageal emptying was demonstrated with residual barium trapped in the pockets between the varices. In some patients there was a general atony of the esophagus between the peristaltic waves, producing a slight resemblance to megaesophagus. Rippling peristalsis can also be well shown by this newer method. The authors note that the respiratory phase has little to do with the size of the varices and they could find no practical use for either the Valsalva or Müller test.

Forty-five roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

The Meaning of a Gas Bubble Projected Above the Level of the Diaphragm. E. Koppenstein. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 569-572, November 1958. (In German) (Uzsoki u. 29-35, Budapest 14, Hungary)

Chest films which demonstrate a bubble of gas above the level of the diaphragm in the region of the stomach or the left flexure of the colon raise the question of a possible hiatal hernia, phrenic hernia, or, rarely, epiphrenic diverticulum. This gas projection is a common finding, and it is easily determined by fluoroscopy whether or not an abnormality is present. The explanation of the phenomenon, however, is not too well known. It is due to the fact that the left leaf of the diaphragm, like the right, has a double cupola. Those individuals in whom the thoracic type of breathing predominates show paradoxical movement of one-half of the cupola on deep inspiration. At the greatest depth of inspiration, the anterior arch of the left leaf of the diaphragm rises instead of falls. If there is gas under this portion of the diaphragm it will, of course, project above the main level. The best term for this is pseudo-paradoxical respiratory motion.

Four roentgenograms; 1 diagram.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

Acute Gastric and Duodenal Ulceration Following Endothoracic Surgery. G. Rothhoff and H. Vieten. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 561-565, November 1958. (In German) (H. V., Moorenstr. 5, Düsseldorf, Germany)

The authors report 29 cases in which acute gastric or duodenal ulceration followed thoracic surgery. Four of these patients died and in 3 of these autopsy showed the cause of death to have been hemorrhage from the upper gastrointestinal tract.

The ulcers tend to occur in the first two postoperative weeks and definitely predominate in childhood. There is a very high correlation with cardiac surgery but none with the thoracotomy itself. Twenty-seven of the authors' 29 patients were operated upon for diseases of the heart and great vessels and 2 for lung ailments. More than half the patients were under fifteen years of age. There seemed to be no correlation of ulcer development with the type of anesthesia, with the length

or difficulty of the surgery, or with the specific cardiac anomaly. Some connection appears possible, however, with the use of hypothermia both on an actual and a theoretic basis. The authors feel that the main cause of the formation of ulcers lies in manipulation with resultant stimulation of the vagus nerve in the region of the heart and great vessels. Recovery is usually prompt. Five roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

Hyperplasia of Brunner's Glands. Maurice L. van der Reis, Leo van der Reis, and B. Vicas. *California Med.* 90: 162-164, February 1959. (2515 Ocean Ave., San Francisco 27, Calif.)

Clinical and radiologic findings in hyperplasia of Brunner's glands are briefly reviewed and an illustrative case is reported. Characteristically the radiographic findings consist of multiple, discrete, small, oval, or rounded filling defects in the first and second portions of the duodenum. These defects in most cases appear to be sessile. They are most numerous in the duodenal bulb, where they produce a so-called "Swiss cheese pattern." The walls of the duodenum remain flexible, and usually there is little associated spasm or irritability. In radiological differential diagnosis one must consider adenomata of the duodenum as well as some other rarer benign tumors. The differential points include, for adenomata, the demonstration of stalks or pedicles and frequently the presence of polyps in other portions of the small bowel. Achlorhydria is frequent with duodenal polyps while gastric hyperacidity is characteristic of hyperplasia of Brunner's glands. Nonspecific duodenitis appears to be the only inflammatory condition capable of simulating hyperplasia of Brunner's glands. With duodenitis, associated findings include irritability of the bulb with or without spasm, inconstancy in size and shape of the small, rounded filling defects, obliteration of the pattern on manual compression, and a regression of the findings on anti-ulcer management. Proper treatment appears to be conservative, with diet, antacids, and anticholinergic drugs. In the case reported complete relief was obtained on such a program.

Two roentgenograms. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Interposition of a Loop of Ileum Between the Dome of Diaphragm and Liver. M. G. Varadarajan. *Punjab M. J.* 7: 343-350, April 1958. (68, Egmore High Road, Madras 8, India)

The author reports a case in which a loop of the ileum was interposed between the right dome of the diaphragm and the superior surface of the liver. The patient was a 37-year-old man, with pain in the right hypochondrium of three years duration. On fluoroscopy of the chest a multilocular cystic swelling was visualized beneath the right dome of the diaphragm. The liver shadow was not demonstrable. There were no paradoxical movements of the diaphragm. The right diaphragm was elevated one intercostal space higher than the left; it was thin and slightly stretched. A barium-meal series suggested ulcers involving the lesser curvature of the stomach and the first part of the duodenum, with a fair amount of stasis at twenty-four hours. In the five-hour film, the cecum was visualized and barium was seen going beneath the right dome of the diaphragm; at twenty-four hours barium was present in the loop of small intestine beneath the right diaphragm.

A barium-ema study showed a certain amount of narrowing beyond the hepatic flexure, continuing down the ascending colon and cecum, which were nearer to the midline than usual. A tentative diagnosis was made of peptic ulcers involving the lesser curvature of the stomach and first part of duodenum, giving rise to pyloric obstruction.

At operation, a loop of the terminal ileum was found between the right dome of the diaphragm and superior surface of the liver. For a distance of about 2 feet, beginning 8 inches from the cecum, it was studded with clusters of cysts, densely in some places and sparsely in others. On biopsy these proved to be lymphangiomas. The ileocecal and mesenteric nodes were enlarged. About the middle of the lesser curvature of the moderately dilated stomach was a vascularized area with omental adhesions; this felt rather hard, suggesting a healed gastric ulcer. There was an ulcer in the first part of the duodenum, with dense scarring and adhesions.

Although there is nothing in the history pointing to perforation of a peptic ulcer, from the physical findings and those at operation the author thinks it is evident that the patient recovered from the minor leak from a minimal perforation which resulted in local peritonitis. This was followed by irregular peristalsis, pushing the coils of intestine to the diaphragmatic level, where they were subsequently anchored.

Colonic hepatodiaphragmatic interposition has been frequently reported, but the author believes that his is probably the first case of small intestinal hepatodiaphragmatic interposition to be recorded. Actually Linsman and Chalek presented a case in 1950 (*Radiology* 54: 726, 1950), and Aiken (*New England J. Med.* 258: 1192, 1958. *Abst. in Radiology* 72: 616, 1959) described a case in which there was hepatodiaphragmatic interposition of jejunum, ileum, cecum, and ascending colon with intestinal obstruction.

Nine roentgenograms; 1 photograph.

A Vascular Study of the Small Intestine. H. B. Benjamin and A. B. Becker. *Surg., Gynec. & Obst.* 108: 134-140, February 1959. (Marquette University School of Medicine, Milwaukee, Wisc.)

New Concept of the Small Intestine Vascular Pattern. Alan B. Becker and H. B. Benjamin. *Rev. canad. de biol.* 17: 460-482, December 1958. (Marquette University School of Medicine, Milwaukee, Wisc.)

The material reported in these two papers is the same. The authors studied the arterial patterns of the small intestine of dogs and man.—i.e., the area between the duodenojejunal flexure and the ileocecal junction—by injecting the superior mesenteric artery with radiopaque material and radiographing the infused bowel segments, or paraffin sections, with grenz rays and roentgen rays. Grenz rays lie between the usual roentgen rays and ultraviolet rays and as a result have a shallow penetrating power found useful in the study of the finer ramifications of the intramural vessels. Bismuth oxychloride was found to be an ideal radiopaque material because its particulate size was such that it stopped at the capillary bed on the arterial side, thus limiting the study to the arterial side of the vascular tree. Diodrast was also used.

The grenz-ray photographs, magnified, were very useful in the study of even minute intramural vessels. The superior mesenteric artery divides into 10 to 16

intestinal arteries which bifurcate distally in such a way as to form intestinal arcades from which arise the vasa recti vessels that directly supply the small intestine. There has been disagreement in the standard anatomical texts about the intramural paths and anastomoses of these vasa recti branches. The authors were able to study these vessels and determine their patterns.

The vasa recti were seen to bifurcate on the mesenteric portion of the bowel and then penetrate the wall to the submucous layer, where a branch runs around each side of the bowel to give a signet ring appearance. The terminal portions of the intramural vessels anastomose on the antimesenteric border, completing the ring. Abundant anastomoses occur throughout the circumference of the ring with adjacent intramural vessels. Branches are sent to the mucosal and serosal surfaces. In the dog there are anastomoses between adjacent vasa recti intramesenterically but these are absent in man.

Both of these papers are illustrated by numerous photographs.

MORTIMER R. CAMIEL, M.D.
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Incidence of Gall Bladder Disease in "Normal" Men. Richard S. Wilbur and Robert J. Bolt. *Gastroenterology* 36: 251-255, February 1959. (300 Homer Ave., Palo Alto, Calif.)

The question of when to remove a gallbladder has been debated at great length in the medical literature and there is much controversy about the surgical indications. The advent of cholecystography has resulted in the discovery of more cases of "silent gallstones" and has intensified the argument.

To decide upon the advisability of surgery in the presence of stones, three factors should be known: (1) the true incidence of biliary calculi in the general population; (2) the percentage of patients harboring calculi who are asymptomatic; (3) the natural course of this asymptomatic group if not operated upon.

An opportunity for obtaining light on the first two of these points was afforded by a group of 1,234 executives who were asymptomatic, a cholecystographic survey having been taken as part of their routine annual examinations in the last ten years. The results were grouped in three classifications: (1) faint visualization, (2) nonvisualization, (3) stones.

Of these "normal men," 14.6 per cent showed some evidence of gallbladder abnormality past or present, although they averaged less than fifty years of age: previous cholecystectomy 2.0 per cent; faint visualization 3.6 per cent; nonvisualization, 1.6 per cent; biliary calculi, 7.5 per cent.

Furthermore, an unexpected high percentage (70 per cent) of patients with stones had no abdominal symptoms. Of the remaining 30 per cent, two-thirds had only the unreliable symptoms of dyspepsia and epigastric pain, complaints which were also found in 10 per cent of the control group. Of the men with previous cholecystectomy and with no other demonstrated cause for symptoms, 31 per cent still had "gallbladder symptoms."

It follows from this observation that there are millions of "normal" male Americans with "silent gallstones." To eradicate all of these gallstones represents an enormous undertaking, which should not be undertaken. Furthermore, many symptoms that may be present are not related to the stones.

Typical "biliary colic" occurs in only 3.6 per cent of

men with stones and in 0.9 per cent of men with normal cholecystograms. Therefore, cholecystectomy, in the absence of true biliary colic or jaundice, should not be performed for relief of vague indigestion or dyspepsia just because stones have been demonstrated.

The authors promise to report in the future about the natural course of the asymptomatic group with stones demonstrated on cholecystography.

Two tables. SHAWKI ASMAR, M.D.
Cleveland Metropolitan General Hospital

Radiographic Signs of Acute Suppurative Cholecystitis. James J. McCort. *California Med.* 90: 139-143, February 1959. (Santa Clara County Hospital, San Jose, Calif.)

A series of 26 pathologically proved cases of acute cholecystitis is reviewed. Preoperative radiographic examination of the abdomen confirmed the presence of an inflammatory process in 17 cases. Routine films of the abdomen made on patients with signs and symptoms indicating infection or tumefaction in the abdomen include anteroposterior supine and upright and left lateral decubitus. Additional studies were performed in some patients if the diagnosis remained obscure. Such studies may include intestinal examinations with barium, intravenous cholangiography, or intravenous pyelography.

The radiographic signs of acute cholecystitis are tabulated, and illustrative roentgenograms are reproduced. Helpful radiographic findings included the following:

1. *Enlargement of the gallbladder* as indicated by separation or alteration in position of opaque calculi or indentation of adjacent bowel, particularly the colon.
 2. Findings indicative of *localized peritoneal irritation*, including ileus of the descending duodenum or hepatic flexure of the colon. More severe degrees of inflammation produce edema of the adjacent bowel wall manifested occasionally by effacement of colonic haustra in the hepatic flexure or obliteration of valvulae conniventes of the duodenum. Similarly produced edema may result in obliteration of the fat line marking the inferior border of the liver.
 3. *Early perforation* of the gallbladder, which may be manifested by small bubbles of gas trapped in the gallbladder bed. Perforation of the gallbladder into the general peritoneal cavity will produce progressive signs of adynamic ileus, intraperitoneal fluid, subdiaphragmatic abscess, and occasionally plate atelectasis at the base of the right lung.
 4. A few patients may show *cholecystitis emphysematosa* as a result of gas-producing bacterial infection within the gallbladder wall.
- It is noted that any of these findings may be shown in acute pancreatitis, and a differential diagnosis may at times be impossible by radiographic means; laboratory studies will frequently help. The diagnostic points under discussion are unusually well demonstrated by carefully chosen roentgenograms, with brief accounts of the clinical and laboratory findings in the cases illustrated.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Vicarious Calcification Involving the Gallbladder. Carleton M. Cornell and Robert Clarke. *Ann. Surg.* 149: 267-272, February 1959. (Bellevue Hospital, New York, N. Y.)

The authors have described and reviewed the condi-

tion of gallbladder calcification, variously designated calcifying cholecystitis or china or porcelain gallbladder. Some 50 cases have been reported since the first description in 1797. At Bellevue Hospital 16 cases were found in 4,271 cholecystectomies from 1922 through 1956.

Signs and symptoms are subtle, indicating only a vague biliary dysfunction. Their duration ranges from several weeks to ten years, seldom including any acute episodes. Diagnosis is by radiography. Since the gallbladder is nonfunctioning, the plain radiograph is the key procedure. To be differentiated are hepatic abscesses, hydatid cysts, kidney calculi, costal cartilages, and appendiceal mucoceles.

Routine blood and chemical studies are unrevealing except with common bile duct obstruction, when alkaline phosphatase will be elevated.

Both the pathogenesis and pathology of gallbladder calcification are discussed, indicating the existence of a basic degenerative change followed by vicarious calcification of the dystrophic type. The calcified viscus is usually large, stony-hard, with a cartilage-like wall impregnated with calcium. Numerous calculi, including cystic duct stones, are found. Calcification of the gallbladder represents complete loss of function with total morphologic change. Carcinoma frequently supervenes.

Two case histories are presented. Two roentgenograms; 2 photomicrographs; 3 photographs.

JOHN C. POWERS, M.D.
St. Vincent's Hospital, New York

The Fatty Meal in Oral Cholecystography. A Re-evaluation, with Comments on "Tumors" of the Gallbladder, and on Its Rokitsansky-Aschoff Sinuses. Christian V. Cimmino. *Am. J. Digest. Dis.* 4: 159-170, February 1959. (Mary Washington Hospital, Fredericksburg, Va.)

Review was made of 188 gallbladder studies with Telepaque in an attempt to answer two questions: (1) Does the fatty meal contribute morphologic information (such as demonstration of filling defects) not visualized on pre-fat studies? (2) Does the fatty meal contribute useful functional information not available from the pre-fat study?

The author's morphologic observations are summarized as follows: "The post-fat film *per se* contributed little to the diagnosis of stones. However, it was of value in 1 per cent of the cases in demonstrating noncalculous filling defects in the upper half of the gallbladder and not in the lower half, by virtue of the increase in density of this segment. . . . The single patient in whom Rokitsansky-Aschoff sinuses were demonstrated showed that these may be obscured by a fatty meal and that their x-ray visualization may be intermittent."

The author feels that diagnostic accuracy is best served by limiting the radiologic description to "simple filling defects." The radiologist cannot differentiate safely between true neoplastic papillomas on the one hand, and inflammatory excrescences, adenomyosis, or occasional rare mesenchymal growths on the other hand. Demonstration of any of these entities may be enhanced on post-fat meal films, but it is the author's opinion that good quality pre-fat meal films will demonstrate the majority of such lesions.

As a criterion of gallbladder function, the response to fat meal stimulus is not reliable. The fatty meal is of

no use in the nonvisualized gallbladder. It is of little or no value in enhancing the density of contrast media to a point where stones can be excluded in cases of poor concentration. "The roentgenological criteria for biliary dyskinesia are still too indeterminate to be of practical use."

It is concluded that the fat meal is not to be recommended as a routine procedure but that in patients with gravitational suboptimal density in the gallbladder infundibulum and in the unusual case of suboptimal concentration without demonstration of stones in spite of repeated studies, contrast demonstration may be enhanced. "Under these conditions, about one-third of the examinations will require the fatty meal."

The multiple small roentgenograms illustrating the paper are not very helpful in demonstrating the minute morphologic points under discussion, probably because of loss of contrast resulting from reproduction.

Eleven roentgenograms.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Side-Effects of Biligradin Forte. Georg-Fredrik Saltzman. *Acta radiol.* 51: 121-127, February 1959. (Serafimerlasarettet, Stockholm, Sweden)

The author studied the frequency and nature of side-effects of Biligradin Forte (a 50 per cent solution of a methylglucamine salt) in a series of 271 biliary tract examinations and reached the following conclusions:

1. The frequency of side-effects of Biligradin Forte is considerably higher than for Biligradin in the form of a sodium salt. The quality of the side-effects seems to be mainly the same for both preparations. It may differ between different examinations in the same patient.
2. The frequency of side-effects is somewhat higher in women than in men.
3. The frequency of side-effects decreases with age in adult patients.
4. Patients with jaundice have no side-effects.
5. The injection speed does not influence the side-effects, either in quantity or quality.
6. The amount of the contrast medium injected does not, within diagnostically practicable limits, influence the quantity or quality of the side-effects.

THEODORE E. KEATS, M.D.
University of Missouri

THE MUSCULOSKELETAL SYSTEM

A Comparative Radiological Study of Reiter's Disease, Rheumatoid Arthritis and Ankylosing Spondylitis. R. M. Mason, R. S. Murray, J. K. Oates, and A. C. Young. *J. Bone & Joint Surg.* 41-B: 137-148, February 1959. (London Hospital, London, E. 1, England).

The radiologic changes observed in Reiter's syndrome (nongonococcal urethritis, polyarthritis, and conjunctivitis) have been previously described (Murray, Oates, and Young: *J. Fac. Radiologists* 9: 37, 1958. *Abst. in Radiology* 71: 778, 1958). The present report concerns the radiologic differentiation of the syndrome from rheumatoid arthritis and ankylosing spondylitis. For this purpose a comparative study was made of radiographs of the hands, feet, ankles, and pelvis of 25 patients with Reiter's disease, 81 with rheumatoid arthritis, and 38 with ankylosing spondylitis.

No absolute means of differentiating the conditions radiologically in all cases was found. Some points, however, are felt to be helpful. In Reiter's disease the

changes are predominantly in the feet and sacroiliac joints with destructive joint changes and deformity. In addition exuberant periosteal new bone formation tends to occur at the calcaneus. Asymmetrical bone and joint involvement is characteristic. Osteoporosis is not common.

In rheumatoid arthritis joint changes tend to be symmetrical; they are accompanied by osteoporosis and there is equal involvement of hands and feet. The sacroiliac joints are involved infrequently and show only mild changes.

In ankylosing spondylitis changes at the sacroiliac joints are early and pronounced. There is mild involvement of the feet.

A florid periostitis of the calcaneus in Reiter's disease was the most significant radiologic finding in this series and is felt to be pathognomonic of the disease.

Twenty-five roentgenograms; 5 tables.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Dysphagia Caused by Hypertrophic Changes in the Cervical Spine. Report of Two Cases. Oliver H. Beahrs and Herbert W. Schmidt. *Ann. Surg.* 149: 297-299, February 1959. (Mayo Clinic, Rochester, Minn.)

Two cases in which hypertrophic changes in the cervical spine had become large enough to produce dysphagia are reported.

Case I: A 52-year-old man gave a nine months history of dysphagia accompanied by burning pain, more pronounced when the neck was extended. Crepitation was observed on motion. Esophagoscopy revealed no evidence of tumor. An esophagram showed "extrinsic pressure on the esophagus in its posterior aspect just below the introitus, probably due to osteophyte." An operation was performed and a spur arising from the anterior portion of the bodies of C-4 and C-5 was removed. It measured $2.5 \times 1.5 \times 1.0$ cm. and weighed 2 gm. There was complete relief of pain and dysphagia.

Case II: A 36-year-old male gave a three months history of dysphagia and pain in the neck, right shoulder, and arm. Roentgenograms of the cervical spine revealed marked lippling of the anterior-superior surface of the body of C-5. An esophagram and cervical myelograms were normal. Diagnostic cervical nerve blocks were carried out in stages. Blocks of the superior laryngeal nerve and 4th, 5th, and 6th cranial nerves produced negative results. Block of the stellate ganglion, however, resulted in complete relief of pain. An operation was performed and the bony process of C-5 was identified. It was thought to be a source of irritation to the sympathetic chain on various types of movement of the neck. The bony lip was excised and the sympathetic chain was interrupted. A Horner's syndrome was produced but postoperatively there was complete relief of dysphagia and pain.

Three roentgenograms; 1 photograph.

CAPT. HOWARD R. GOULD, M.C.
St. Vincent's Hospital, New York

Bony Bridges Following Transverse Process Fractures of the Lumbar Vertebrae. C. Esser. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 579-590, November 1958. (In German) (Langenbeckstr. 1, Mainz, Germany)

Bony bridging of the transverse processes is an infrequent but striking roentgen finding. Reports in the literature have been relatively few, and in general

limited to individual case histories. In most instances they have emphasized a developmental origin. With this the author is not in agreement.

A bony bridge of traumatic origin is irregularly broad, spans two or more transverse processes, is usually unilateral, and may be either continuous or with intervening pseudarthroses. Both smooth and irregular bone has been seen, and in some instances the bone becomes well trabeculated, although the general tendency is for an amorphous structure. There appear to be no significant predisposing developmental anomalies of the involved spine and thus far the condition has not been reported in childhood. A slight scoliosis appears to be quite common, but the bone bridge may be either on the convex or the concave side of the curvature.

In view of the frequency of fractured transverse processes, it is amazing that there are not more of these bony bridges seen in the radiography of elderly people. The author reports a case in which there was an injury in 1945, with fracture of the transverse processes. A re-examination in 1958 revealed a strong bony bridge at the site of the previous trauma, though this had not been present earlier. In this instance, as in many others, the ossification outlined the muscle bundle, and thus the condition actually represented a localized myositis ossificans.

Twelve roentgenograms.

WILLIAM F. WANGNER, M.D.
Royal Oak, Mich.

Results of Abrodil Myelography in Prolapse of the Lumbar Intervertebral Disk. C. W. Fassbender, G. Häussler, and H. G. Stössel. *Fortschr. a. d. Geb. d. Röntgenstrahlen* 89: 574-578, November 1958. (In German) (Allgemeine Krankenhaus, Hamburg-Heidelberg, Germany)

Prolapse of an intervertebral disk as a degenerative process is related to age, type of occupation, and vertebral structure. In the neurological examination, the exact level of involvement may be revealed or may be ambiguous. Lumbarization and sacralization of the vertebrae in particular create confusion as to the nerve level.

One of the authors (Häussler) has operated in 950 cases of prolapsed disk since 1938. For the first eleven years operation was done without contrast studies. Between 1949 and 1958, 470 patients were examined by abrodil myelography prior to surgery. Toward the end of this period plain film studies were ignored, since no correlation was found between simple demonstration of a low disk and the level of prolapse. While abrodil is considered the contrast agent of choice, it is not devoid of risk. Headaches frequently follow its use, seizures have resulted, and an occasional death has occurred.

The authors' technic differs from that commonly used in the United States. No fluoroscopy is performed. The day before filming, the patient is tested for abrodil sensitivity by the intracutaneous method. On the day of the examination, lumbar puncture is performed with the patient sitting. Three cubic centimeters of 5 per cent Novocaine is injected directly into the spinal canal and, when anesthesia of the legs appears, the patient is placed on the left side and the table is tilted head up 20° . Ten cubic centimeters of abrodil is then injected and the spinal needle removed. A lateral view is taken. Following this, the patient is placed on the abdomen and a single postero-anterior exposure is made. Two decubitus views are obtained, and the

patient is returned to his room. The contrast medium is not removed.

In the 470 patients, the correlation with the surgical findings was as follows. In 125 cases, there was complete agreement between neurological, surgical, and roentgen findings. In 282 cases, there was complete correlation between the surgical and radiologic findings but questionable neurologic agreement. In 2 patients, a prolapsed disk was suspected neurologically and a deformity was demonstrated on the myelogram but no prolapse could be found surgically. In 8 patients in whom the roentgenogram was positive for a prolapsed disk, surgery demonstrated either scar tissue, an osteophyte, or a slight developmental anomaly. In 27 patients with negative myelograms, disks were shown at surgery. In this group of 27 cases, at least 23 were probably reducible disk herniations, and roentgenograms with the patients in dorsal flexion might have demonstrated the abnormality. Eighteen patients with findings which were clinically confusing showed no disk prolapse on myelography but were nevertheless operated on. All were negative surgically.

At present, the correlation between the x-ray and the surgical diagnosis is 88.6 per cent. This percentage may be slightly vitiated, however, by the fact that only rarely is a roentgenographically positive patient not treated surgically. By the same token, the surgeon is not too inclined to operate upon a patient who is radiographically negative. The correlation between neurologically objective positive findings combined with positive radiography and surgical observation is 97 per cent. A small but significant group of patients, despite this correlation of all three diagnostic modalities, show the same symptoms following surgery as before.

WILLIAM F. WAGNER, M.D.
Royal Oak, Mich.

Resolving Scoliosis. J. C. Scott. *J. Bone & Joint Surg.* 41-B: 105-113, February 1959. (Nuffield Orthopaedic Centre, Oxford, England)

It is generally accepted that, in scoliosis, once a curve with structural changes is present in a growing child, it will increase; that the main prognostic factor is the period of growth that lies ahead of the patient. This, however, is not entirely true. Other factors play a part.

Earlier studies by the author showed a high percentage of infants with a curve of more than 10 degrees at six months with no measurable deformity at eighteen months to two years (*Proc. Roy. Soc. Med.* 49: 398, 1956. See also Scott and Morgan: *J. Bone & Joint Surg.* 37-B: 400, 1955. *Abst. in Radiology* 66: 916, 1956). This resolving type of scoliosis was considered to be a natural alignment of the infantile spine which was corrected by assumption of the erect posture.

Four cases are reported here which illustrate a scoliosis first diagnosed during infancy, with gradual disappearance during the period of active growth. The curve pattern was the same in all four, convex to the left and involving the lower half of the thoracic spine.

Seventeen roentgenograms; 6 charts.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Dorsal Kyphosis in Chronic Obstructive Lung Disease. Denis F. J. Halmagyi. *Lancet* 1: 446-448, Feb. 28, 1959. (University Medical School, Sydney, Australia)

Osteoarthritis of the spine was investigated in 300

patients with chronic obstructive lung disease and in 60 persons of comparable age with no respiratory complaints. Both groups consisted of coal miners. The indirect maximal breathing capacity was determined in all patients in Group I and in the last 10 patients in Group II.

Lateral chest roentgenograms were used to measure the spinal curve if they gave a clear picture of the entire spine. Tangents were drawn to the anterior borders of the second and eleventh thoracic intervertebral spaces. The angle facing upwards—called the "kyphotic angle"—was measured with a protractor in 28 patients, twice on two separate films of each patient. The mean kyphotic angle was 46°. In 3 the two measurements differed by 4°; in 5 by 3°; and in the rest by 0-2°. Three measurements on three separate films were made in 13 patients. Their mean kyphotic angle was 49°; in 1 the results differed by 6°; in 2 by 5° and 4° respectively, and in the rest by 0-3°.

Around the age of thirty the angle of kyphosis was about equal in the two groups, but with advancing age miners with diseased chests became more kyphotic than miners with healthy chests. Nonspecific chronic osteoarthritis of the spine was also more common in this group. The author concludes that increased tendency to dorsal kyphosis is probably related to the earlier onset and greater prevalence of chronic osteoarthritis.

The indirect maximum breathing capacity showed a significant negative correlation to the kyphotic angle. Electrocardiographic signs of right ventricular hypertrophy were related to the maximum breathing capacity but not to the degree of kyphosis.

One roentgenogram; 5 graphs.

Osteoid Osteoma of Vertebrae. W. T. Mustard and F. W. DuVal. *J. Bone & Joint Surg.* 41-B: 132-136, February 1959. (F. W. DuVal, Winnipeg Children's Hospital, Winnipeg, Man., Canada)

Two case reports of osteoid osteoma of vertebrae are presented. Both patients were young boys seen because of pain and a scoliosis. Radiological examination revealed an area of increased density in the first thoracic vertebra in one instance and a radiolucent defect of the first lumbar vertebra in the other. Both patients were subjected to surgery, the lesions were curetted, and autogenous bone grafts were applied. Histologic study established the diagnosis. Follow-up at six or seven years revealed symptomatic relief and absence of scoliosis.

Reports of only 25 cases of osteoid osteoma of vertebrae were discovered. The noteworthy features of the present cases were the initial complaints of pain and scoliosis, the uncertain radiologic findings, the similar position of both lesions, involving vertebral body, neural arch and articular facet, and the disappearance of pain and scoliosis following removal of the lesions.

Six roentgenograms; 2 photomicrographs.

JOHN F. RIESSER, M.D.
Springfield, Ohio

Congenital Short Femur. Simple Femoral Hypoplasia. P. A. Ring. *J. Bone & Joint Surg.* 41-B: 73-79, February 1959. (Hospital for Sick Children, Great Ormond St., London, England)

Defects in femoral development may vary from diminished growth without loss of bony structure to complete or partial absence of the bone. Congenital

coxa vara may be associated with shortening and deformity of the femur. The major group of cases, however, show a simple femoral hypoplasia without coxa vara. Radiographs commonly reveal no abnormality aside from the shortening, but there may be delayed ossification of the capital femoral epiphysis, lateral bowing, and cortical sclerosis of the shaft. Clinically there is a short, bulky thigh held in lateral rotation. The diagnosis can be made at birth. Nineteen cases are reviewed in tabular form.

Simple femoral hypoplasia would appear to be a distinct clinical entity, the result of a defect in endochondral ossification. It is often associated with depression of growth in the tibia and there may be a congenital defect of the fibula. Despite a normal radiographic appearance there is a progressive disturbance of femoral growth throughout the growth period, but the overall shortening of the limb seldom exceeds 3 inches.

Operative procedures are briefly considered. These include lengthening the short femur, shortening the normal femur, a combination of both measures, and epiphyseal stapling in milder cases.

Six roentgenograms; 2 photographs; 1 table.

JOHN F. RIESSE, M.D.
Springfield, Ohio

The Effects of Kwashiorkor on the Development of the Bones of the Knee. P. R. M. Jones and R. F. A. Dean. *J. Pediatr.* 54: 176-184, February 1959. (Mulago Hospital, Kampala, Uganda)

Roentgenograms of the knees of 75 African children (44 boys, 31 girls) admitted for treatment of kwashiorkor [a deficiency disease possibly related to pellagra] were compared with those of 47 healthy children of the same age. Thirty of the children with kwashiorkor were re-examined after three to forty months. Retardation in development was found in both sexes. The bones were smaller, less well calcified, and had much less trabecular pattern than those of healthy children. They also showed several abnormalities not present in the normal child: (a) The cortex of the shafts of the femur and tibia was often very thin or almost invisible (in 95 per cent of the boys and 84 per cent of the girls). (b) The zones of provisional calcification in the metaphyses of the femur and tibia could not be clearly seen (in 95 per cent of the boys and 97 per cent of the girls). (c) The concave profiles of the lower part of the femoral shaft and the upper part of the tibial shaft were interrupted by slight but distinct swellings best seen in the anteroposterior view, suggesting fusiform distortion of the shafts (in 57 per cent of both boys and girls). (d) There were dense white lines at the ends of the femoral and tibial metaphyses (in 97 per cent of the boys and 77 per cent of the girls). (e) There was irregularity of the calcification of the edges of the femoral and tibial epiphyses (in 82 per cent of the boys and 77 per cent of the girls).

Transverse lines, indicating past disturbances of growth, were present on the femur or tibia in 84 per cent of the boys and 74 per cent of the girls with kwashiorkor. Only 22 per cent of the healthy boys and 10 per cent of the healthy girls exhibited such lines.

The hands of the same children were also studied roentgenographically. Comparisons suggested, but did not conclusively prove, that the knee may be a more accurate indicator than the hand of the retardation of bone development associated with kwashiorkor. The hands of the children with the disease did not show

the minor anomalies that have been described in other children with nutritive failure.

Two roentgenograms; 2 drawings; 2 graphs; 1 table.

Experimental Epiphysal Injury and Freiberg's Disease. G. T. F. Braddock. *J. Bone & Joint Surg.* 41-B: 154-159, February 1959. (Royal National Orthopaedic Hospital, London, W. 1, England)

The term Freiberg's "infraction" connotes an element of trauma in the causation of this particular deformity of the head of the second, third, or fourth metatarsal. Debate continues, however, as to the role of injury in this disease.

Fresh necropsy specimens of the articulated second metatarsal and proximal phalanx were subjected to varying amounts of weight—from 1 to 4 pounds—dropped from heights of 3 to 21 inches onto a plunger in a cylinder containing the bones. Force was thus applied to the longitudinal axis of the bones and repeated until a fracture occurred. The phalanx fractured first in 8 of 10 specimens. In two instances, bones from eleven- and twelve-year-old girls, the metatarsal epiphysis was fractured. It is of interest that in these two cases the stage of epiphysal maturation compared closely with that seen in early Freiberg's infraction. In these two cases radiographs showed little change.

Five cases of Freiberg's disease are discussed with reference to the radiologic findings. Fracture of the metatarsal epiphysis has not been demonstrated. Increased density of the epiphysis has been found, and it is postulated that this represents evidence of callus production. Thickening of the shaft of the affected metatarsal, which occurs later, is felt to be due to stress secondary to loss of dorsiflexion at the metatarsophalangeal joint. The altered shape of the metatarsal head in late, healed cases represents residuals of avascular necrosis secondary to the epiphysal fracture.

Seven roentgenograms; 4 photographs; 1 diagram; 1 table.

JOHN F. RIESSE, M.D.
Springfield, Ohio

GYNECOLOGY AND OBSTETRICS

The Method of Transfer of Labour Contractions to the Contents of the Uterus. G. Narik. *J. Obst. & Gynaec. Brit. Emp.* 56: 58-61, February 1959. (I. Universitaets-Frauenklinik, Vienna, Austria)

How the forces produced by the contracting uterine wall are transferred to the uterine contents is one of the main problems of the mechanism of labor. The supposition that the expulsion of the fetus is mainly brought about by hydraulic force is challenged by the author, and an alternative explanation is offered, based upon radiological examinations carried out during delivery on 60 primiparae. To limit exposure to irradiation, no more than four or five roentgenograms were taken of any one patient—frontal (anteroposterior) and lateral views in the first stage (cervix two-fingers dilated) and again early in the second stage when the presenting part had reached the pelvic floor. By additional use of a soft-tissue technic and of intra-uterine instillations of a radiopaque contrast fluid, it was possible to visualize certain soft-tissue structures of the parturient uterus.

X-ray studies showed (1) maintenance of the fundus at about the same level during descent of the presenting

part to the pelvic floor, (2) downward displacement of the margins of the external os during dilatation, (3) gradual and progressive straightening of the fetal spine and apposition of the extremities to the body during each contraction, (4) characteristic change in shape of the uterus during the course of labor from a relatively spherical to a more cylindrical outline, (5) shifting of the amniotic fluid from the upper to the lower segment of the uterus.

The author believes that conditions within the uterus should be compared not to those within a rigid hydraulic system but to those in an elastic system. Shift of amniotic fluid from the upper to the lower uterine segment brings about a direct apposition between the upper segment of the uterine wall and the fetus. Resultant straightening of the fetal spine plays an important role in the mechanism of parturition. It is only when the forewaters rupture that a full application of a hydraulic expulsive force is possible.

Eleven roentgenograms.

The Mid-Pelvis in Pelvimetry. J. R. Gerace. *Canad. M. A. J.* 80: 166-168, Feb. 1, 1959. (304 Medical Arts Bldg., Windsor, Ont., Canada)

In reviewing the mechanisms of labor and re-evaluating x-ray films of the pelvis, the author has been impressed by the association of aberrations in delivery with a short posterior sagittal diameter of the midpelvis. This diameter is the distance from the ischial spine to the sacrum as measured along Hodge's third parallel. A reconsideration of Hodge's parallels, the author believes, will lead to a better orientation as to the state of progress in labor. The first of these parallels is in the inlet. The second is from the arch of the pubis to the lower part of the second sacral segment. The third parallel cuts the ischial spines, and the fourth goes through the tip of the coccyx and represents the pelvic floor.

In the normal gynecoid pelvis, the head descends posteriorly, and flexion and rotation are accomplished by the concave wall of the sacrum and the pelvic diaphragm. When the transverse diameter of the midplane of the pelvis (the interspinous distance) is narrowed, the bulk of the fetal head must pass either anteriorly or posteriorly to the spines. Only rarely is the forepelvis large enough to permit descent and rotation anterior to the spines, so that in the vast majority of patients the posterior sagittal diameters are the critical measurements. If the posterior sagittal of the midpelvis is not sufficiently large, then labor will be arrested at this site.

In reviewing the literature, the author concludes that the midpelvis is the level of prime obstetrical importance. Although he states that the posterior sagittal at the midpelvis is the "one diameter of importance in the whole pelvis," he emphasizes that all the diameters and the general pelvic contour must be taken into consideration in evaluating the adequacy of the pelvis for normal delivery.

Four diagrams. **RICHARD H. GREENSPAN, M.D.**
University of Minnesota Hospitals

Danger of Embolism with Oily Contrast Media. A Study of the Problem of Media in Hysterosalpingography. R. Frischkorn. *Schweiz. med. Wchnschr.* 88: 1267-1269, Dec. 13, 1958. (Universitätsfrauenklinik, Göttingen, Germany)

A discussion of the general hazards of hysterosalpin-

gography and a description of the author's technic comprise the first part of this report. Forty per cent Iodipin is used unless such inflammatory changes as genital tuberculosis are suspected. In these instances a water-soluble contrast medium is employed.

The second part of the paper consists of a report of a case in which intrauterine injection of 8 c.c. of 40 per cent Iodipin was followed by massive invasion of the contrast oil into the venous plexus. From the uterine venous plexus, the medium progressed into the ovarian and uterine veins. The author is certain that an oil embolism occurred, although there were no objective or subjective signs of this. During this event, the 32-year-old white patient, who had entered the hospital in good condition, felt perfectly well. There were no cerebral symptoms, either on the day of the examination or subsequently.

The author is of the opinion that the danger of oil embolism in hysterosalpingography should not be regarded as a contraindication to the use of oily contrast media.

Three roentgenograms.

HERBERT POLLACK, M.D.
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THE GENITOURINARY SYSTEM

Screening Urethrocytography of Adult Bantu Males Under Manometric Control. Normal and Pathological Findings. T. Fichardt. *Brit. J. Radiol.* 32: 120-131, February 1959. (Pretoria General Hospital and University, Pretoria, Union of South Africa)

One hundred adult Bantu males (1 cadaver; 22 normal subjects; 77 with disease of the urinary bladder and urethra) were investigated by screening urethrocytography under manometric control. The procedure is begun either (1) by allowing Micropaque to flow under pressure into the urethra and urinary bladder or (2) by injecting Pyelosil 70 per cent under pressure into the urethra and bladder. The anterior and posterior portions of the urethra are then observed fluoroscopically and radiographed in various positions, after which the bladder is allowed to fill with Micropaque or with sterile saline if Pyelosil 70 per cent is being used. Fluoroscopic observations are made and films of the bladder are obtained prior to and during the act of micturition.

A cadaver, adult Bantu male aged twenty-eight years, was used for study of the radiological anatomy of the urethra and bladder. Two main divisions of the urethra are recognized: (a) the anterior urethra, consisting of the pendulous penile, fixed perineal, and bulbous portions, and (b) the posterior urethra, consisting of the external urethral sphincter, prostatic urethra, and internal vesical sphincter. There was no evidence of a musculus compressor nudaee between the two divisions in the specimen. Furthermore, the indentation in the anterior urethra attributed to this muscle (Morales and Romanus: *Acta radiol.* 39: 453, 1953. *Abst. in Radiology* 62: 627, 1954) was not observed in any of the 100 Bantu studied. Either the muscle is absent in the Bantu or the lack of constant pressure during injection produced the indentation seen by Morales and Romanus.

In the normal group of 22 men, ages twenty to thirty-five years, there were several interesting findings: (1) The external sphincter is recognized by the pencil-point

appearance of the anterior urethra as the lumen narrows when it reaches the closed sphincter. A constant critical pressure is required to open the sphincter in any individual. The pressure range is from 40 to 60 mm. Hg. (2) The posterior urethra acts as a single unit both during retrograde filling and micturition. (3) The muscular wall of the bladder is in a state of tonic contraction as filling begins; with the desire to micturate, the bladder becomes elongated vertically. During micturition it empties "like a pricked balloon," without contraction waves.

The findings in benign prostatic hypertrophy were elongation and angulation of the prostatic urethra, hypertonicity of the sphincters, umbrella depression of the neck of the bladder, and hypertrophy of the bladder wall. The damaged post-prostatectomy internal sphincter is recognized by a patulous vesical neck, a ragged dumbbell deformity at the site of the internal vesical sphincter, a normal external urethral sphincter, and normal act of micturition. The external urethral sphincter controls the bladder outlet and provides normal micturition. In the neurogenic bladder, the neck of the bladder is patulous, and a smooth, funnel-shaped deformity occurs at the internal vesical sphincter site. The external sphincter again is normal and controls micturition. The efficiency of the cord bladder is judged by noting the force of contraction of the bladder, force of the urinary stream, emptying time of the bladder, presence of calculi in the urinary tract, and folds of mucous membrane blocking the vesical opening. In two cases studied following operative damage of the external sphincter, the internal sphincter controlled micturition without aid of the external sphincter.

Sixty-two roentgenograms; 1 photograph; 1 diagram.
S. B. HAVESON, M.D.
Los Angeles, Calif.

Should Intravenous Pyelography Be a Routine Procedure for Children with Cryptorchism or Hypospadias?
Lester M. Felton. *J. Urol.* 81: 335-338, February 1959. (New York Hospital, New York, N. Y.)

"Is the incidence of urinary anomalies in patients with cryptorchism or hypospadias high enough to warrant routine intravenous pyelography?"

Campbell (*Am. J. Surg.* 82: 8, 1951) in a series of 292 cases of cryptorchism coming to autopsy found additional urogenital anomalies in 33 per cent. The present author reviewed the records of 289 patients with cryptorchism seen over a ten-year period and found that of 61 of this number in whom intravenous urography was done without other indication, 13.5 per cent had major anomalies of the upper urinary tract. In the same ten-year period, 142 patients with hypospadias (penile and penoscrotal) were seen, and in 53 of these intravenous urography was performed as a routine procedure. Eight of the group were also cryptorchid, and in 2 of these, as well as in 4 others, upper urinary anomalies were revealed.

The incidence of unsuspected urogenital abnormalities in these two groups—13.5 per cent for cryptorchism and 9 per cent for hypospadias—is compared to an incidence of 2 per cent in an autopsy series of 152 boys of two to fourteen years. In view of this it is concluded that, until it is demonstrated that the radiation from one diagnostic pyelogram is a serious hazard to the individual patient, intravenous pyelography is a worthwhile part of the evaluation of children with either crypt-

orchism or hypospadias. Some suggestions for reducing radiation exposure are offered.

Eight tables.

M. M. MISHKIN, M.D.
University of Pennsylvania

The Usefulness of a Contrast Medium Containing an Antibacterial Agent (Retrogratin) for Retrograde Pyelography. Joseph Bloom and J. F. Richardson. *J. Urol.* 81: 332-334, February 1959. (U. S. Naval Hospital, St. Albans, N. Y.)

The risk of introducing or spreading infection in the urinary system remains a hazard in retrograde pyelography. In a series of 100 patients with known urinary tract infection or obstructive uropathy, retrograde pyelography was performed with a new contrast medium, Retrogratin, a mixture of sodium and methylglucamine diatrizoates in 30 per cent concentration containing 2.5 per cent neomycin sulfate, a potent antibacterial agent. The addition of neomycin did not impair the quality of the radiographs, and allergic manifestations, such as febrile response, oliguria, or anuria, occasionally encountered with other contrast media, did not appear. Most important to the urologist, as well as the patient, was the lack of evidence, in all 100 cases, of new infection or spread of established infection after the administration of Retrogratin.

ROBERT E. CAMPBELL, M.D.
University of Pennsylvania

MISCELLANEOUS

Dermoid and Epidermoid Tumors in the Central Nervous System of Adults. Collin S. MacCarty, Milam E. Leavens, J. Grafton Love, and James W. Kernohan. *Surg., Gynec. & Obst.* 108: 191-198, February 1959. (Mayo Clinic, Rochester, Minn.)

Seventy-seven cases of epidermoid and dermoid tumors of the central nervous system were seen at the Mayo Clinic before 1955. The present discussion is limited to 63 patients of 15 years or older, of whom there were 44 with epidermoid tumors and 19 with dermoid tumors. The writers deal with all of the clinical aspects of these tumors, but this abstract will be mainly concerned with the radiologic findings.

Epidermoid tumors are of congenital origin, made up of the outer layer of the epidermis, squamous epithelium containing keratohyaline granules, and desquamated epithelium, with occasionally an outer layer of fibrous and connective tissue. Dermoid tumors are teratomas composed primarily of skin and its derivatives; they present calcification more frequently than epidermoids.

Congenital anomalies were associated with 3 of the epidermoids and 50 per cent of the dermoids. These included anomalous fusion of various vertebrae, cyst of the septum pellucidum, dermoid sinuses, harelip, pilonidal sinus, cyst under the occipital portion of the scalp at birth, cervical rib, meningocele, and spina bifida. A surprising number of patients in both groups had mental symptoms.

Epidermoid Tumors: Of the 44 epidermoid tumors, 3 were intraorbital, 14 intradiploic, 24 intracranial, and 3 intraspinal. **Intraorbital epidermoid tumors** all caused proptosis in addition to other symptoms; in each of the 3 cases erosion of the orbit was visible roentgenographically.

Roentgenograms of *intradiploic epidermoid tumors*

were usually characteristic, showing involvement of both tables by a smooth, scalloped, sclerotic margin around an area of decreased density. At times both tables appeared expanded or destroyed. In several instances, a curvilinear calcification represented the intracranial wall of the tumor.

Of 24 *intracranial epidermoid tumors*, 8 were in the cerebellopontile angle. Apparently the clinical syndromes are more helpful in diagnosing these tumors than are radiographic methods, although ventriculography was occasionally helpful. Seven patients had intracranial epidermoid tumors in the region of the sella turcica. The skull roentgenograms were normal in 3 cases, but in 4 cases there were various demonstrable changes about the sella or optic canals. In 1 case, not included in this report, calcification was present. In 4 patients with tumors about the temporal lobe, roentgenograms were negative in 1 case, there was secondary clinoid erosion in 1 case, and pineal shifting in 2 cases. Ventriculography was helpful twice, and in 1 case a left carotid angiogram revealed an avascular tumor in the left sylvian region. The remaining miscellaneous tumors did not give specific radiologic findings, although ventriculography was of some assistance.

Erosion of the vertebrae was present in 2 of the 3 cases of *intraspinal epidermoids*. In the remaining 1, roentgenography of the spinal column was normal but myelography revealed the tumor.

Dermoid Tumors: The 19 dermoid tumors were located as follows: 9 intracranial, 4 intradiploic, 1 intraorbital, and 5 intraspinal.

Of 9 *intracranial dermoid tumors*, 6 were supratentorial and in all there were abnormal roentgen findings. These included enlargement of the sella, calcification in the suprasellar tumors, erosion of the dorsum and floor of the sella, and destruction of the posterior clinoids. One tumor in the frontal lobe and 3 of the suprasellar tumors showed calcification. There were 3 patients with infratentorial tumors. None had dermal sinuses or skull defects.

The roentgenographic appearance of the *intradiploic dermoid tumors* was similar to that of intradiploic epidermoid tumors.

There was but 1 patient with an *intraorbital dermoid tumor*, showing unilateral proptosis of thirteen years duration. The radiologic findings are not described. Examination revealed a mass behind the globe.

Intraspinal dermoid tumors were present in 5 patients. Roentgenograms revealed spina bifida of varying degree in 3 cases and widening of the space between the pedicles in 1 instance. Myelography was used to outline the tumor in 3 cases.

Five roentgenograms; 6 tables.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Epidural Tuberculous Abscess Simulating Herniated Lumbar Intervertebral Disk. A Case Report. Henry G. Decker, Seymour W. Shapiro, and Howard R. Porter. *Ann. Surg.* 149: 294-296, February 1959. (VA Hospital, Des Moines, Iowa)

A case of a tuberculous epidural abscess unassociated with tuberculosis of the spine, meninges, or other organs is reported. The signs and symptoms were those of a herniated lumbar intervertebral disk.

The patient was a 67-year-old male with a three-month history of low back pain and right-sided sciatica, aggravated by coughing, sneezing, or motion of the

spine. A chest film showed two small calcifications in the right paratracheal region. Films of the lumbar spine revealed narrowing of the L5-S1 interspace, osteophyte formation, and sclerotic changes around the sacroiliac joints. A Pantopaque myelogram demonstrated a constant extrinsic pressure defect at the L5-S1 right interspace, with blunting of the nerve root sleeve. An intravenous pyelogram was normal.

A laminectomy was performed and the right L5-S1 nerve root was found to be tense and impinged upon by a mass that exuded purulent material. The dura and surrounding osseous structures were not involved. Histologic examination of the lesion revealed a non-specific granuloma in the epidural adipose and connective tissue. Direct smear and culture demonstrated acid-fast organisms which, on guinea-pig inoculation, proved to be a virulent strain of *Mycobacterium tuberculosis*.

Complete relief of radicular pain was obtained following surgery. An intensive diagnostic work-up postoperatively failed to reveal either active or chronic pulmonary or genitourinary tuberculosis. The authors feel that the epidural abscess resulted from hematogenous dissemination of the infecting organism from a subclinical primary focus, probably in the lung.

One roentgenogram.

CAPT. HOWARD R. GOULD, M.C.
St. Vincent's Hospital, New York

Roentgen Aspects of Blastomycosis. W. L. Boswell. *Am. J. Roentgenol.* 81: 224-230, February 1959. (1221 S. Broadway, Lexington, Ky.)

The author reports five cases of systemic blastomycosis and describes the roentgen findings, including follow-up examinations.

Pulmonary blastomycosis may manifest itself by different roentgenographic patterns, there being no characteristic appearance. A differential point mentioned in the literature—namely, marked pleural involvement out of proportion to parenchymal disease—was not demonstrated in the author's cases. Inasmuch as the disease is a granuloma, it must be considered with and differentiated from tuberculosis, coccidioidomycosis, moniliasis, histoplasmosis, and torulosis.

Patients with blastomycosis involving bone often present themselves with chronic draining sinuses. Roentgenograms show either bone destruction or periostitis. In any patient with bone involvement, a roentgenogram of the chest should be made because the lung is considered the portal of entry. Blastomycosis should be considered when a destructive bone lesion is found along with pulmonary or pleural involvement.

Eighteen roentgenograms.

RICHARD A. ELMER, M.D.
Atlanta, Ga.

TECHNIC

Transverse Laminagraphy: The Third Dimension in Body Section Roentgenography: Applications in Radiation Therapy. Bernard Roswit, Sol M. Unger, Joseph Stein, Stanley J. Malsky, and Cyprian B. Reid. *Am. J. Roentgenol.* 81: 130-139, January 1959. (VA Hospital, Bronx 68, N. Y.)

Transverse laminagraphy has received much attention in Europe for over two decades, but until recently little has appeared in the American literature. The authors present their experience with this modality

over the past five years at the Bronx Veterans' Hospital.

The planning of roentgen therapy to deep-seated lesions requires construction of accurate graphic cross sections at the treatment level for localization of the tumor, selection of portals, and orientation of beams. The addition of transverse laminagraphy to the conventional vertical studies greatly enhances the delineation of the volumetric limits of the tumor, as well as providing details of organ displacement by the mass. The principle and technic of the procedure are presented, with accompanying diagrams, photographs, and radiographs. These are of excellent quality and aptly illustrate the value of the third dimension in body-section roentgenography.

It is in the head, neck, and thorax that transverse laminagraphy has been found most helpful as a prelude to treatment planning. Laminagrams of radium implants in the tongue and mouth are of particular value in reconstructions and dosage calculations. In check studies following treatment, transverse laminagraphy provides an excellent method of demonstrating tumor regression and in evaluating the final result.

Seventeen roentgenograms; 4 photographs; 6 diagrams.

NORMAN L. ARNETT, M.D.
Anaheim, Calif.

Serial Tunnel for Radiography During Operations.

Eric Samuel. *Lancet* 1:454, Feb. 28, 1959. (195 Jeppe St., Johannesburg, Union of South Africa)

Radiography during surgical procedures has been hampered by the difficulty of obtaining serial films. The author describes a relatively simple cassette tunnel, which permits up to six serial radiographs to be taken

without disturbing the operative field. The apparatus consists of a tunnel 6 ft. 6 in. \times 2 ft. 3 in., corresponding to the size of a standard operating table. The upper surface of the tunnel is made of lead plywood (1 mm. lead equivalent) except for a 12 \times 10-in. or 15 \times 12-in. area, made of Perspex, at the junction of the middle and upper thirds. The Perspex window is decentered so that it lies two-thirds to the right of the midline when a 12 \times 10-in. area is used. With a 12 \times 15-in. area, the widest part of the window lies across the table. A linen runner with six pockets carries 12 \times 10-in. or 12 \times 15-in. cassettes. The two pockets which lie at the head end of the tunnel contain two dummy cassettes.

The linen runner and the cassettes are loaded into the tunnel preoperatively, and the whole tunnel is placed on the operating table and covered with a radiotransparent foam-nylon mattress. The patient is positioned on the table so that the right hypochondrium lies over the Perspex window and centered before the surgical cleansing. The first of the four cassettes is already in place beneath the window. The films are withdrawn by hand-pulling on the linen runner from the head end of the table. Only the cassette which lies under the Perspex window is exposed, the rest being protected by the lead-ply upper surface.

The apparatus has been found satisfactory for operative cholangiography, splenopography, and other procedures which do not require rapid cassette changing. The author believes it less cumbersome and less time-consuming than the tunnel described by Rosenberg and Sampson (*Am. J. Surg.* 93: 878, 1957. *Abst. in Radiology* 70: 442, 1958).

Two photographs.

RADIOTHERAPY

Carcinoma of the Larynx. Results Obtained By Surgery and External Radiation in Ninety-Three Cases. William M. S. Ironside, James W. J. Carpender, Robert Roedal, and John R. Lindsay. *J.A.M.A.* 169: 783-786, Feb. 21, 1959. (950 E. 59th St., Chicago 37, Ill.)

A series of 93 cases of carcinoma of the larynx treated not less than five years ago is presented. Seventy per cent of the lesions originated in the vocal cords and 29 per cent in the supraglottic area. There was only 1 subglottic case, which was in Stage 2 when laryngectomy was done. The overall five-year survival rate in the supraglottic group was 37 per cent and in the glottic 65 per cent.

The choice of treatment, whether surgery or irradiation, was influenced to some extent by both the location and the stage of the lesion. Surgery as the primary form of treatment gave superior results in Stage 2 and Stage 3 supraglottic tumors. Some patients in these groups who received primary irradiation were subsequently operated upon. In the Stage 1 glottic cases the five-year survival figures are 80 per cent for surgery and 70 per cent for irradiation. In Stage 2 cases, also, surgery appeared to have a slight advantage. One of 2 patients with a Stage 3 glottic lesion lived five years, but none of 5 receiving irradiation survived. One patient with Stage 4 glottic disease lived five years after irradiation followed by operation.

Irradiation factors were 250 kv; h.v.l. 3 mm. copper; treatment distance 50 cm. (thick individuals 80 cm.). Bilateral fields, directly opposed, were used, ranging from 4 \times 4 cm. to as large as 6 \times 8 cm. The tumor

dose was from 5,000 to 5,500 in thirty-five to forty-two days. Skin reactions were severe, with wet dermatitis.

It is suggested, on the basis of the findings, that patients with supraglottic and subglottic lesions should receive primary surgery, including bilateral neck dissection, except for Stage 1 cases, which should be offered external irradiation as primary treatment. Patients with Stage 1 and rarely Stage 2 glottic lesions should be treated primarily by external irradiation, provided careful follow-up can be assured. Surgery should be used in late Stages 2, 3, and 4, with bilateral neck dissection in Stages 3 and 4 and in cases with subglottic or supraglottic extension.

Four tables.

GORDON L. BARTEK, M.D.
Grand Rapids, Mich.

Simple Mastectomy and Postoperative Irradiation for Carcinoma of the Breast. A Report from the Saint John General Hospital. J. A. Caskey. *Canad. M. A. J.* 80: 251-254, Feb. 15, 1959. (Saint John General Hospital, Saint John, N. B., Canada)

At the beginning of 1952, the staff of the Saint John General Hospital, Saint John, N. B., decided, wherever possible, to apply the McWhirter plan of simple mastectomy and postoperative irradiation to all cases of breast carcinoma referred for treatment.

The 257 cases recorded in this article are all those seen between 1952 and 1956 and include 27 (10 per cent) that were treated radically, 202 (79 per cent) which received the McWhirter treatment, and 28 (11 per cent) given palliative x-irradiation only, hormones,

or no treatment at all. All deaths were attributed to cancer even though postmortem studies in several cases revealed no evidence of malignancy. The follow-up was 100 per cent, with no untraced cases. The average age of the patients was 55.9 years, the oldest patient being ninety-four and the youngest twenty-four. The survival rates at the time of this report were 52 per cent for 133 Stage I patients, 22 per cent for 57 Stage II cases, 7.5 per cent for 19 Stage III cases, and 18.5 per cent for 48 Stage IV patients.

Radiotherapy was commenced during the second post-operative week and was given in 15 treatments over a three-week period. In the author's 1952-1954 cases treated by simple mastectomy and postoperative irradiation, those which received 3,750 r or more, centrally in the axilla, had a three-year survival rate of 78 per cent as opposed to 46 per cent for those who received less than 3,750 r. For patients under sixty-five these rates were 79.5 and 28.5 per cent respectively. The rate for Stage I was 89 per cent against 75 per cent; for Stages II-IV, 53 per cent against 10 per cent.

These results suggest that the policy of abandoning the radical operation in favor of simple mastectomy and postoperative irradiation was justified. It is pointed out, however, that under present circumstances survival figures for breast cancer from different treatment centers cannot be compared. Infinite variations in the composition of the cases, in clinical and pathological assessment, and in both surgical and radiation treatment methods make such comparisons invalid.

Five tables.

Primary Fibrosarcoma of the Lung in a Young Child. A Case Treated by Lobectomy and Cobalt Therapy. F. S. Gerbasi, A. M. Margileth, and R. S. Kibler. *J. Pediat.* 54: 488-495, April 1959. (F. S. G., 2201 E. Jefferson Ave., Detroit 7, Mich.)

Primary fibrosarcoma of the lung, in general, is relatively rare. Its occurrence in a child under three years of age is still more unusual; the authors could find no record of such a case in the literature. Their patient was a boy of two years and nine months. Roentgenograms of the chest were taken because the child seemed to be having some difficulty in breathing. These disclosed a well defined, circular, homogeneous density in the lower half of the right lung field measuring approximately 6 cm. in diameter. The borders were fairly sharply outlined, and the mass was seen in its entirety in the right lower lobe. It was not connected to the diaphragm or to the posterior chest wall. The right minor fissure and the lower portion of the major fissure were also seen as slightly accentuated lines, and there were no signs of atelectasis of the middle lobe. There was no evidence of compression of the surrounding pulmonary tissue nor was there any displacement of the cardiac or mediastinal structures.

The right lower lobe of the lung was excised. The histologic diagnosis was anaplastic fibrosarcoma. For a few months the patient had no complaints. Approximately five months after lobectomy roentgen examination of the skeleton and chest was normal except for a minimal soft-tissue density in the right lower posterior lung field. A right thoracotomy showed the hilus to be infiltrated with tumor tissue, most of which appeared to be encapsulated by a thin, bluish-white membrane. Since nothing could be accomplished surgically in view of the massive involvement of the mediastinum, the child was referred for cobalt-60 therapy. There was a

slight decrease in the size of the metastatic nodules following irradiation, as demonstrated roentgenologically, but this was hardly worth mentioning, and no subjective improvement occurred. The patient died thirteen months after the onset of symptoms.

Three roentgenograms; 2 photomicrographs.

Advantage of Aimed Pendulum Roentgen Therapy of Esophageal Carcinoma. Werner Hellriegel. *Strahlentherapie* 108: 43-51, January 1959. (In German) (Universitäts-Röntgeninstitut, Frankfurt a. M., Germany)

Carcinoma of the esophagus is known to be especially radioresistant. Although progress has been made with surgical and radiotherapeutic measures in the last few decades, more effective approaches are still required.

A distinct improvement has recently been achieved with the pendulum type of high-voltage roentgen therapy. The author used this technic in 63 of a series of 145 patients with esophageal cancer seen from 1954 to 1957. All the cases were far advanced. Twenty-five patients had metastatic spread when first seen (to the liver in 10, to the lungs in 1, to the neck and regional nodes in 11, and to the skeletal system in 2). In the remaining case an affected lymph node had invaded the wall of the aorta. Malnutrition, emaciation, dysphagia, and weight loss were of common occurrence. Nausea and vomiting were noted less frequently, and paresis of the recurrent laryngeal nerve was observed in only 4 cases.

The average age of the patients was sixty-five, females being affected somewhat earlier than males. The history dated back four to five months (average). In only 47.6 per cent was treatment started within three months of onset of symptoms. The proximal third of the esophagus was involved in 21 per cent, the midportion in 44 per cent, and the distal third in 35 per cent. In 8 cases with involvement of the distal two-thirds of the esophagus the history dated back twelve months and more, suggesting a rather slow growth. The survival of this group was two to seventeen months. Two of these patients were still alive eighteen months after receiving a tumor dose of 6,000 r with the pendulum technic.

In 41 cases gastrostomy was performed. This procedure proved beneficial not only for by-passing an area of stenosis but also for avoiding trauma to the tumor from ingested food. Of a group of 16 gastrostomy patients, 4 were still alive three years and more following irradiation.

Two types of moving-tube therapy were employed—convergent beam irradiation in 16 patients and the pendulum technic in 47. Other patients were treated with the stationary tube. It was found that pendulum therapy, when properly planned and applied, was far superior to other technics, including contact therapy with radium or radioactive cobalt. The technical factors were 200 to 250 kvp, 2 mm. Cu h.v.l., 50 cm. tube-skin distance, and 4 cm. width of field. The length of the field depended on the extent of the tumor.

Nine patients were too sick for a regular series and therefore received less than 1,000 r. Eighty-four per cent of 76 patients treated with stationary-tube technic died within the first year against 56 per cent of those receiving pendulum therapy. Improvement following the first series of treatments was noted in 55.8 per cent. A total tumor dose of less than 4,000 r had but little effect on the course of the disease, but the survival rate

showed marked improvement with doses of 6,000 r. This latter dose could almost always be accomplished with pendulum therapy but rarely with the stationary-tube technic.

The average survival rate was 6.7 months with stationary-tube therapy against 9.8 months with the moving-tube treatment. Recurrences developed later and less frequently following a proper course of pendulum treatments.

ERNEST KRAFT, M.D.
Northport, N. Y.

Sieve (Grid) Radiotherapy of Subcutaneous Lymphoma. E. Krokowski. Fortschr. a. d. Geb. d. Röntgenstrahlen 89: 591-596, November 1958. (In German) (Strahleninstitut der Freien Universität, Berlin-Charlottenburg 9, Germany)

Subcutaneous and superficially located lymphoma is best treated with intermediate roentgen therapy such as will deliver a 50 per cent depth dose in 3 to 5 cm. of tissue. The present investigation is concerned with the determination of any advantage in using the sieve or grid technic with this quality of radiation. The author did fairly extensive depth dose determinations, using four different grids, each 6 X 8 cm. Three of the grids had holes of 5.5 cm. diameter and the fourth had holes of 1.1 cm. diameter. The grid percentages were 28.6, 39.2, 40.5, and 47.5. Despite the limited nature of the investigation, some probably valid conclusions are reached, based on studies on cadavers, phantoms, and patients.

The first conclusion is that, if the lymph node can be easily delineated clinically, if there is no bone or cartilage in the field to be irradiated, and if the node is subcutaneous, intermediate therapy should be used; that is, radiation generated at 110 kvp, with a small open field. Under these circumstances the use of a grid was not found to be of any advantage. The second conclusion is that, if the same conditions prevail but the field includes bone or cartilage, one should treat with a similar tumor dose but use 200-kvp radiation, a small open field, and again no grid. Finally, for extensive neoplasms in the cervical or axillary region, grid therapy at 200 kvp is preferred; the grid should permit a 40.5 or 47.6 per cent transmission of radiation, and the openings should be 1.1 cm. in diameter. For extensive inguinal involvement, similar treatment is used, again with a grid, but sometimes with less penetrating radiation.

Seven figures; 3 tables.

WILLIAM F. WAGNER, M.D.
Royal Oak, Mich.

Malignant Lymphomas of the Gastrointestinal Tract. Joe W. Frazer, Jr. Surg., Gynec. & Obst. 108: 182-190, February 1959. (Duke University School of Medicine, Durham, N. C.)

Thirty-one cases of malignant lymphoma of the gastrointestinal tract were seen at the Duke University Hospital (Durham, N. C.), between 1930 and 1952. These included 8 reticulum-cell sarcomas, 9 lymphoblastic lymphosarcomas, 12 lymphocytic lymphosarcomas, and 2 mixed types. There were no cases of Hodgkin's disease or giant follicular lymphoma. Eighteen of the tumors were of gastric origin, 11 were in the small bowel, and 2 were in the colon.

Gastric Lymphomas: The average age of the patients with gastric lymphoma was fifty-two years. Symptoms were not characteristic, but an ulcer-like syndrome was

frequent. Radiologic evaluation was the most important diagnostic procedure. Seventeen of the 18 patients showed an abnormality, but the diagnosis was specifically suggested only once. On 12 occasions a filling defect was noted; 3 cases showed hypertrophied rugal folds, and 2 resembled gastric ulcer. The site within the stomach did not help in differentiation from other lesions.

Radiation therapy was given to 6 of the 7 patients whose disease was beyond the scope of surgery. Four received some palliation with reduction in mass size and improvement in well-being. All 6 died within six months. Radiation was also used in 5 of the 9 cases in which resection for cure was attempted. Of the 9 patients, 7 lived longer than five years. One of this group who died of a recurrence had not been irradiated. Of the remaining 6 long-term survivors, 4 received postoperative irradiation.

Lymphomas of the Small Bowel: The average age in this group was thirty-five years. The presenting clinical picture was that of intestinal obstruction, and obstruction was demonstrated by roentgen examination in 7 cases. In 1 patient a barium enema study disclosed an ileocecal defect and the possibility of a lymphoma was suggested. Five patients received radiation after surgery, but palliation was obtained in only 2. Of three long-term survivors, none received postoperative radiation therapy.

Lymphomas of the Colon: Two cases of lymphoma of the colon were seen, one in a six-year-old boy who died two months after surgery in spite of radiation therapy; the other in a fifty-one-year-old male who died postoperatively.

The author emphasizes the tendency of these gastrointestinal neoplasms to remain localized for long periods. The five-year cure rate is high. Seven of 18 patients with gastric lymphoma are living or lived longer than five years, while 3 of 11 with lesions of the small bowel survived more than five years. Wide surgical excision with postoperative radiation therapy is recommended as the best form of therapy.

One photomicrograph; 4 photographs; 4 tables.

MORTIMER R. CAMIEL, M.D.
Brooklyn, N. Y.

Hemangioma with Thrombocytopenia. Harold W. Dargeon, Amparo C. Adiao, and George T. Pack. J. Pediatr. 54: 285-295, March 1959. (Memorial Center for Cancer and Allied Diseases, New York, N. Y.)

Hemangioma with associated thrombocytopenia is relatively rare. The authors review 14 cases in which these two entities were observed: 9 from the literature and 5 (2 of which were previously recorded) from the Pediatric and Mixed Tumor Service of the Memorial Center (New York). All but 1 of the tumors were observed at birth or early infancy. In the exceptional case the hemangioma was noted at the age of eighteen months. Thirteen patients showed cutaneous evidence of hemangioma; 1 child never exhibited any cutaneous component of the tumor, and its identity was not established until biopsy was performed nine months after the onset of the illness.

Splenectomy was carried out in 6 of the 13 treated cases. In 1, a satisfactory effect on the thrombopenia and tumor was observed within one week after the operation. In the other 5 cases the thrombopenia persisted from three to five months. The serious operative and postoperative problems which are sometimes en-

countered are dramatically illustrated by the hemiplegia which occurred in 1 of the cases reported here.

Steroids were used in 4 cases. There was cessation of purpura in 1 patient, in spite of persistence of the thrombopenia. There was slight improvement of the thrombopenia in another. The first patient was on an elimination diet also.

X-ray or radium therapy was administered in 10 cases, and proved to be of value in 7 (including 1 case reported by the authors). In 1, there was only temporary regression of the tumor. In the authors' case the tumor continued to increase in size until three months after the insertion of radon gold seeds, when it was first noticed to be smaller. At the same time, there was significant increase in the platelet count from 20,000 to 134,000 per cubic millimeter. From then on, the tumor progressively decreased in size, and the platelet count rose to a normal level.

Subsidence of the thrombocytopenia always coincided with, or followed, regression of the tumor. The various attempts to explain this relationship are discussed. Utilization and destruction of platelets in the angiomatous mass are considered the most likely explanation.

Nine photographs; 2 tables.

Treatment of Pterygium by Surgery Followed by Beta Radiation. An Analysis of 256 Cases. Walter Lentino, Milton M. Zaret, Bertrand Rossignol, and Sidney Rubinfeld. *Am. J. Roentgenol.* **81**: 93-98, January 1959. (Bellevue Hospital, New York, N. Y.)

The authors report a series of 256 patients treated at Bellevue Hospital (New York) with beta-rays following surgical excision. Initially, the beta-ray therapy was given with a radon applicator but later a strontium-90 applicator was used.

Operation was followed within one week by a beta-ray surface dose of about 2,500 rep to the limbus. This was repeated in two weeks. One hundred and sixty-six cases with an observation period of at least six months are analyzed. Among these there were 6 failures, with subsequent recurrence. Three of the failures were unexplained; 3 were due to inadequate surgery, inadequate irradiation, or delay between surgery and irradiation. The study thus indicates that no amount of irradiation is a satisfactory substitute for inadequate surgery, and that insufficient irradiation or too long a delay following surgery increases the chances of recurrence.

The immediate irradiation reactions in this series were self-limited and usually of brief duration. Delayed reactions included (1) telangiectasia of the conjunctiva, in approximately 50 per cent of the patients; (2) keratinization of the conjunctival epithelium, in 1 patient after four years; (3) corneal vascularization and scarring; (4) superficial punctate keratitis. No case of cataract developed, though this cannot be disregarded

as a future possibility. At present, a dosage schedule of 1,000 rep at weekly intervals for three weeks is being used to establish whether it is possible to obtain satisfactory results and still minimize the risk of immediate and late sequelae.

The authors recommend that re-operation followed by beta radiation be used routinely in the treatment of recurrent pterygia.

Four figures; 4 tables.

NORMAN L. ARNETT, M.D.
Anaheim, Calif.

Subacute Thyroiditis. H. Clarkson Meredith, Jr. *Virginia M. Month.* **86**: 80-82, February 1959. (746 Graydon Ave., Norfolk, Va.)

A case of subacute thyroiditis with hyperthyroidism in a 34-year-old white female is reported. Complete recovery followed a regimen of Meticorten plus 150 r of irradiation in divided doses. It is felt that the x-ray therapy probably shortened the course of the disease.

Integral Doses at 200 kV and 8 MeV. D. K. Bewley, A. L. Batchelor, J. Lowe, E. Nataadidjaja, G. R. Newbery, and R. Opie. *Brit. J. Radiol.* **32**: 36-46, January 1959. (Hammersmith Hospital, London, W. 12, England)

The lack of success in correlating clinical reactions with integral dose may be due to the difficulty of obtaining a reliable estimate of integral dose or it may be that integral dose is not the best available statistic, owing to variation in the size of individual patients. Perhaps average dose (integral dose divided by mass) might be more significant.

Calculations of integral dose for 8 Mev were made, from isodose charts based on measurements in water along the axis and diagonals of the fields. At 200 kv it is not possible to use isodose charts for accurate calculations because of the large contribution from volumes where the percentage depth dose is so small that it is not recorded on such charts. Therefore, the method of Meredith and Neary was used here. Calculated values were checked by measurement on the "Celluloid Man," of which a description is given. Agreement was good.

Integral doses based on the same dose to the center of the tumor are compared for the two qualities of radiation. There is not much difference when typical treatment plans are compared (1) because compression is possible with 200 kv, (2) because isodose lines at 200 kv are curved, giving a relatively large dose to the center of the tumor, and (3) because 8 Mev permits the use of fields in which the beam traverses greater thicknesses of tissue. On the other hand, if the same field arrangement is compared for the two energies, the integral dose is greater with 200 kv.

Fourteen figures; 6 tables. LUCILLE DU SAULT
The Henry Ford Hospital

RADIOISOTOPES

Treatment of Thyrotoxicosis with ^{131}I . A Review of 500 Cases. G. W. Blomfield, H. Eckert, Monica Fisher, H. Miller, D. S. Munro, and G. M. Wilson. *Brit. M. J.* **1**: 63-74, Jan. 10, 1959. (University of Sheffield, Sheffield, England)

This article represents a considerable experience, being based on 500 carefully observed cases of thyrotoxicosis

treated with ^{131}I . The following groups were included: (1) patients over forty-five years of age; (2) younger patients with associated diseases with a shortened life expectancy (to less than twenty years); (3) patients with relapses following thyroidectomy or (4) medical (antithyroid) therapy. Pregnancy is a complete contraindication.

The intended dose to the thyroid was 7,000 rads in the average uncomplicated case of thyrotoxicosis with higher or lower doses according to individual indications. Accurate prediction of the dose is difficult and great accuracy cannot be achieved. A method of calculation used by the authors is:

$$\frac{\text{Expected rads/mc.} = 820 \times 48\text{-hour } ^{131}\text{I uptake in preliminary tracer study}}{\text{Estimated gland weight in gm.}}$$

The actual irradiation dose estimated retrospectively is measured by the following formula:

$$\text{Dose in rads} = \frac{164 \times T \times U \times M}{W}$$

where T is the effective half-life of the isotope in the thyroid, U is the estimated peak percentage uptake of the therapeutic dose, M is the dose in millicuries, and W is the estimated thyroid mass in grams.

After the first treatment, 59 per cent of the authors' series became euthyroid and 10 per cent hypothyroid. A further 21 per cent became euthyroid after two or more treatments. The overall incidence of hypothyroidism was 12 per cent.

Of factors influencing the response to treatment gland size was the most important, but this was difficult to determine accurately. The highest incidence of hypothyroidism occurred in the patients with small glands, the size of which was probably overestimated. The age of the patient and wide variations in uptake and half-life of ^{131}I in the thyroid did not have any consistent effect on the clinical result.

Tracheal compression or deviation by an enlarged thyroid was evident radiologically in 78 patients but was not a contraindication to the use of ^{131}I .

In 160 out of the 500 patients the thyrotoxicosis was associated with cardiac complications. Congestive cardiac failure was present in 60 patients, and two-thirds of these, followed for periods of one to seven years after successful treatment of the thyrotoxicosis with ^{131}I , remained free from further attacks of failure. Auricular fibrillation was observed in 90 patients before treatment and normal sinus rhythm was subsequently restored in 33.

Thirty of the authors' 500 patients had died at the time of this report. There was no evidence that any of the deaths were attributable to ^{131}I therapy. One patient treated after the collection of the original series died of acute leukemia about fifteen months after receiving 4.9 mc of the isotope.

In conclusion, the authors state that, though ^{131}I is effective and safe in the present state of knowledge, it should be given to patients under forty years of age only when other methods of treatment have failed or cannot be used. In older patients it is the method of choice.

Four roentgenograms; 2 photographs; 7 graphs; 9 tables.

SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

The Treatment of Disease of the Thyroid by Irradiation. W. P. Holman. M. J. Australia 2: 825-827, Dec. 20, 1958. (Cancer Institute Board, Melbourne, Victoria, Australia)

In contrast to the earlier rigid selection of patients for radioiodine therapy, it is now widely held that this is the treatment of choice for smooth toxic goiters, being contraindicated only during pregnancy (after the twelfth

week) and lactation. A single dose of 7 millicuries is used for the average patient, with 8 millicuries for "large" glands, 9 for "very large" glands, and 6 for small or postoperative glands. Antithyroid medication should be discontinued two days prior to the administration of ^{131}I and may be resumed two days after treatment and continued for a maximum of six weeks.

The author discusses the possible radiation hazards. He has heard of no instance of carcinoma developing following treatment. Two reported cases of leukemia he attributes to coincidence. Genetic hazards are dismissed on the grounds of the low dosage. With a therapeutic dose of 7 millicuries, the tissues receive, on an average, 4 rads, which can be taken as the whole-body irradiation. The reproductive organs receive 10 rads, which is of the same order as from some diagnostic procedures.

Two cases of metastasizing cancer of the thyroid were treated. In one of these a satisfactory result was achieved. The second patient obtained some relief but in this instance isotope therapy was supplemented by 3,000 r of x-irradiation. The author does not advocate radioiodine treatment of toxic nodular goiters.

Six tables.

PAUL MASSIK, M.D.
Quincy, Mass.

Effect of Oral Lipiodol on Thyroidal ^{131}I Uptake and Serum Protein-Bound Iodine Concentration. Anne C. Carter, Shirley Weisenfeld, and Eleanor Z. Wallace, with the technical assistance of Harold Schwartz and Marguerita Pascullo. J. Clin. Endocrinol. 19: 234-238, February 1959. (State University of New York College of Medicine at New York City, N. Y.)

Organic iodine compounds used in roentgenologic diagnosis have been shown to elevate the level of protein-bound iodine (PBI) and/or lower the uptake of ^{131}I by the thyroid gland for prolonged periods of time. Lipiodol, when used for bronchography or myelography, is one such agent, presumably because it is so slowly absorbed from the lungs and spinal canal.

A study to determine the effect of orally administered Lipiodol on serum PBI and ^{131}I uptake was undertaken in 4 euthyroid male patients (ages twelve to fifteen years; 2 with spina bifida and 2 with muscular dystrophy). Each patient received 20 ml. of Lipiodol (containing 540 mg. of iodine per ml.) orally.

Thyroidal twenty-four hour ^{131}I uptakes (normal range 15-50 per cent) after an oral dose of 10 microcuries of ^{131}I and serum protein-bound iodine (normal range 4.0-8.7 micrograms per 100 ml.) were determined before oral administration of Lipiodol and at intervals thereafter for the duration of the study (445 days). Free iodine (FI) was taken as the difference between the total iodine and PBI. FI, according to Astwood, does not normally exceed 2 micrograms per hundred milliliters.

In all 4 subjects the thyroidal ^{131}I uptake was suppressed immediately after the administration of Lipiodol and remained low (usually below 15 per cent uptake per twenty-four hours) throughout the duration of the study. The PBI concentration showed a very great initial rise, dropping somewhat rapidly over the next three or four months. Thereafter, the PBI level dropped very slowly, if at all, and remained above normal for the duration of the study.

The level of FI was determined late in the study and found to be elevated in all 4 patients. At the end of the study (445 days) it was still high in the 2 patients with muscular dystrophy, but normal in the others.

It is concluded by the authors that Lipiodol, when taken orally, may affect certain thyroid function studies (I^{131} uptake and PBI) for a prolonged period, just as it can when used in myelography or bronchography. The study seems to indicate that the medium is absorbed and stored in an unknown site and that iodine is presumably released continually in quantities that are sufficient to lower the I^{131} uptake and elevate the levels of PBI.

One graph; 1 table. JOSEPH M. BEHUN, M.D.
Mercy Hospital, Pittsburgh

Isotope Circulation Studies in Congenital Heart Disease. Richard H. Greenspan, Richard G. Lester, James F. Marvin, and Kurt Amplatz. *J.A.M.A.* 169: 667-672, Feb. 14, 1959. (University of Minnesota, Minneapolis, Minn.)

Some of the advantages and limitations of angiocardiology, cardiac catheterization, and conventional radiographic technics in the definitive diagnosis of congenital heart disease are reviewed. Right-to-left shunts in particular may be difficult to detect and localize accurately. A new procedure is described for demonstration of such a shunt. I^{131} -labeled sodium and methylglucamine diatrizoate (Renografin) serves as a rapidly excreted radioactive tracer. Three carefully placed collimated scintillation counters are utilized: one over the precordium, one over a peripheral lung field, and one over a femoral artery. Injection of the radioactive material is made into the various chambers of the heart by way of a catheter inserted through a vein, or occasionally by direct venipuncture. Doses of radioactive material average about 1 microcurie per kilogram of body weight for the initial studies. Larger doses must be used for multiple injections in order to detect accurately changes over background body activity. The time of appearance of increased radioactivity and the relative degree of activity at the three measurement sites have been found to give valuable information that cannot be obtained from electrocardiograms, pressure recordings, and angiocardiology alone. Specialized, transistorized, compact and portable electronic recording devices were developed by these workers for their study.

In 42 patients suspected of having right-to-left shunts the procedure described has given reliable and helpful information. Characteristic findings include a shortened heart-to-femoral artery circulation time in right-to-left shunts (about two seconds as compared to the normal five to twelve seconds). In left-to-right shunts, the appearance time of radioactivity in the femoral artery is normal but the degree of activity shows a slow rise rather than the usual rapid elevation seen in normal individuals. Seventeen studies in patients with mitral stenosis indicated delayed appearance of radioactivity in the femoral artery up to about twenty seconds after its appearance in the heart. Characteristic graphs are presented for the entities under study.

This method is easily performed and obviates the need for puncturing the femoral artery, which is particularly likely to be difficult in infants and young children. The procedure appears to be fairly reliable in demonstration of small shunts of a type which may be missed by the usual angiocardiology studies because of the passage of insufficient amounts of contrast material through the shunt.

Five figures. JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Use of Radioactive Isotopes in the Study of Colonic Absorption. J. K. Isley, A. P. Sanders, K. W. Sharpe, R. J. Reeves, and G. J. Baylin. *Am. J. Roentgenol.* 81: 89-92, January 1959. (Duke University Medical Center, Durham, N. C.)

The preferential absorption of certain materials by the colonic mucosa forms the basis for the present study of its integrity by the use of radioactive labeled material. The investigation consisted of two parts, one pertaining to man and the other to dogs. For both the subjects were divided into four groups, each receiving a different I^{131} -labeled material: sodium iodide, oleic acid, glycerol trioleate, and human serum albumin. These substances were introduced per rectum along with a barium-enema. After the procedure, the groups were again divided as to normal or abnormal depending upon the barium-enema findings.

In the human group, both normal and abnormal, there was no definite evidence of absorption of the labeled oleic acid, glycerol trioleate, or human serum albumin. There was absorption of the ionic iodine in every case. Some absorption of all of the materials from the dog colon was noted, with the exception of oleic acid.

In those persons shown to be normal by barium enema examination, the average percentage of administered dose in the blood was higher than in those with chronic colon disease. This was specifically true in chronic ulcerative colitis. It seems likely therefore that this procedure, or one similar to it, may prove useful in evaluating the colonic mucosa.

Four tables. NORMAN L. ARNETT, M.D.
Anaheim, Calif.

Deposition and Storage of Vitamin B₁₂ in the Normal and Diseased Liver. George B. Jerzy Glass. *Gastroenterology* 36: 180-190, February 1959. (New York Medical College, Flower and Fifth Avenue Hospitals, New York, N. Y.)

This paper deals with some of the new data collected by means of isotope technics on the deposition and storage of B₁₂ in the liver.

Radioactive B₁₂ was obtained by incorporating a short-lived Co⁶⁰ or Co⁵⁸, or a long-lived Co⁶⁰, into the B₁₂ molecule. All of these isotopes emit strong gamma radiation which can be quantitated by means of a scintillation counter. Thus, the content of radioactive B₁₂ in a given organ can be determined easily.

In studying the mechanisms governing hepatic deposition, storage, and discharge of Vitamin B₁₂ in health and disease, the author determined and analyzed the surface radioactivity over the liver in 100 normal individuals and in 36 with various hepatic diseases, following the administration of Co⁶⁰ B₁₂. Studies were also made in 8 patients with pernicious anemia in remission. The radioactivity was also measured in the liver (1) by external recording, (2) in serial surgical liver biopsies, and (3) in the internal organs at autopsy, in 8 dogs, observed for seven to ten months following administration of a single dose of radioactive B₁₂.

In normal individuals, the administration of radioactive B₁₂ by mouth results in an accumulation of radioactivity over the liver. In pernicious anemia or after total gastrectomy, the hepatic uptake is nil or present only in traces; when intrinsic factor is added, the uptake becomes normal. In sprue, B₁₂ is again not absorbed in the intestine and the hepatic uptake is nil or present only in traces. The addition of intrinsic factors is without influence in these cases.

In liver disease, the hepatic uptake is decreased and, as expected, is not elevated by the addition of intrinsic factor. A diseased liver is unable to deposit and store B_{12} and a high B_{12} blood level is observed, due in part at least, to the inability of the damaged liver cells to remove B_{12} from the circulation.

The liver is the main storage organ for vitamin B_{12} in man and the dog. In man the discharge of the vitamin from the liver is very slow—much slower than in dogs—the biologic half-life averaging ten months, with individual variations ranging from five to thirty months. This explains the long remissions in pernicious anemia, after adequate treatment, and the long latent periods preceding the development of B_{12} deficiency and macrocytic anemia in dietary B_{12} deprivation and following total gastrectomy.

Ten figures; 1 table.

SHAWKI ASMAR, M.D.

Cleveland Metropolitan General Hospital

Rate of Production of P^{32} -Labeled Lymphocytes. Seymour Perry, Charles G. Craddock, Jr., Lutz Ventzke, Gaetano Crepaldi, and John S. Lawrence. *Blood* 14: 50-59, January 1959. (University of California Medical Center, Los Angeles, Calif.)

Experiments are reported which confirm previous studies showing that enough lymphocytes enter the blood stream through the thoracic duct to replace those circulating in the peripheral blood several times daily. The thoracic ducts of mongrel dogs were cannulated and lymph was collected at various periods following the administration of P^{32} , up to one hundred and forty-four hours. A DNA extraction technic was employed.

That the maturation time for lymphocytes is extremely short appears to be established by the fact that the curve of the thoracic duct lymphocyte DNA- P^{32} activity shows an early peak. After this peak has been reached, interpretation of the curve becomes more difficult. The authors point out that this may reflect (1) cells labeled continuously to an extent proportional to the plasma P^{32} and released immediately upon maturation, or (2) cells labeled only at the initially high plasma P^{32} level and gradually released, or (3) both. It is also pointed out that the cells probably leave the blood very rapidly after entry from the lymphatics because there is no sharp rise to the curve of the labeled (or newly formed) lymphocytes in the peripheral blood. [The experiment described is a meticulous one but will work out with a good technic, which will probably be improved upon when other more specific isotopic labeling technics are developed.—S.F.T.]

Nine figures.

SYDNEY F. THOMAS, M.D.

Palo Alto, Calif.

Effect of Anaemia and Transfusion Polycythaemia on Phosphorus and Iron Uptake in Erythrocyte Precursors in Rat Bone Marrow, Studied by Means of a Triple Tracer Technique with ^{32}P , ^{59}Fe and ^{51}Cr . Joseph P. Kriss, Edwin O. Field, and John E. Gibbs. *Brit. J. Haemat.* 5: 92-101, January 1959. (E. O. F., Royal Marsden Hospital, London, England)

The authors note that bleeding, acute hemolysis, and hypoxia cause an increased rate of hemopoiesis as judged by reticulocytosis, by an increased Fe^{59} uptake detectable over the femur, an accelerated rate of appearance of newly formed Fe^{59} -labeled erythrocytes in the circulation, and by an increased concentration of nucleated erythrocytes in the marrow. The plasma of such anemic or hypoxic animals contains a substance which is capable of stimulating erythrocyte release in normal or hypophysectomized recipients.

Conversely, transfusion is followed by a decreased rate of appearance of newly formed erythrocytes. Repeated blood transfusion causes bone marrow atrophy and fibrosis, reduces the number of circulating reticulocytes, and suppresses the appearance of Fe^{59} in circulating red cells.

The design of the experiment reported here was to determine whether the P^{32} uptake of marrow cells of rats could be inhibited by transfusion and increased by bleeding, and to compare the stages at which P^{32} and Fe^{59} , respectively, were incorporated into erythrocyte precursors.

Using Cr^{51} for labeling, the authors made the following observations:

"Two days following a single transfusion of packed red cells the ^{32}P uptake of marrow cells was significantly suppressed, and the rate of appearance of ^{59}Fe in circulating erythrocytes was reduced. The ^{59}Fe content of marrow cells was reduced at four hours but was equal to or greater than that of controls twenty-four hours after administration of the isotope.

"Evidence is presented to support the belief that ^{32}P and ^{59}Fe label different marrow-cell populations, and that inhibitory or stimulating mechanisms may affect different stages in the maturation cycle to different degrees.

"This work is considered to provide the experimental basis for an attempt to inhibit ^{32}P uptake of normal marrow cells of human patients receiving the isotope for therapy of neoplastic disease."

A method is described in the appendix to this paper for measuring the activities of Fe^{59} and Cr^{51} in the same sample.

Seven figures, including 2 photographs; 3 tables.

SYDNEY F. THOMAS, M.D.

Palo Alto, Calif.

RADIATION EFFECTS

Radiation Nephritis. Report of a Fatal Case. Bernard F. Schreiner and Robert M. Greendyke. *Am. J. Med.* 26: 146-151, January 1959. (Strong Memorial Hospital, Rochester, N. Y.)

A fatal case of radiation nephritis in a 14-year-old boy is reported. The patient was first seen on July 11, 1955, because of painless enlargement of the right testicle noted nine days before. Physical examination was normal except for the testicular mass. A chest roentgenogram and intravenous pyelogram were normal. Radical excision of the right testicle was performed on

July 19, and the tumor proved to be a teratocarcinoma. On July 26 a right, radical, retroperitoneal lymph node dissection was carried out; no evidence of metastatic tumor was found. On August 8 a course of deep x-ray therapy to the abdomen was started. A total tumor dose of between 4,400 r maximum and 4,000 r minimum was administered over a period of twenty-six days through anterior and posterior 10×20 -cm. ports on either side of the abdomen. Irradiation was well tolerated, although a marked erythema and some desquamation of the skin occurred over the treated sites.

The patient did well until December 1955, when increasing fatigability, exertional dyspnea, palpitations, marked pallor, nausea, vomiting, and tarry stools led to re-admission to the hospital. Blood pressure was 146/85 mm. Hg. Positive findings included small left axillary and supraclavicular lymph nodes and a small left retinal hemorrhage. The skin over the anterior and posterior abdomen bilaterally showed moderate x-ray pigmentation and numerous small telangiectases. There was a profound normochromic anemia with a hematocrit of 11.5 per cent, reticulocytosis of 12 per cent, and a white blood cell count of 17,700 per c. mm. Urinalysis revealed 3-plus proteinuria, microscopic hematuria and pyuria, and occasional hyaline and granular casts. Stool specimens were tarry and gave a 4-plus guaiac reaction. The blood urea nitrogen was 54 mg. per 100 ml.

The patient's symptoms abated following multiple transfusions but no source for the gastrointestinal bleeding was found. Intravenous pyelography revealed poor concentrating ability; drainage structures on the right were not visualized. Following discharge from the hospital, uremia and melena persisted, necessitating two further hospitalizations during the next sixty days. Physical findings were unchanged except for the appearance of labile hypertension and more prominent dermal telangiectases. Meticcorten was given in an effort to decrease gastrointestinal bleeding, thought to be related to diffuse telangiectasia. Blood urea nitrogen rose to 117 mg. per cent. Two days later progressive improvement occurred associated with sudden return of appetite, considerable diuresis, progressive fall of blood urea nitrogen to 42 mg. per cent and less gastrointestinal blood loss.

During the following month anasarca developed with a fixed hypertension, and the administration of Meticcorten was discontinued. Moderate leukopenia and thrombocytopenia were noted for the first time, and there was a question of splenic enlargement. Gastrointestinal bleeding increased, and uremia became more severe. Death occurred on April 4, 1956.

Findings at autopsy duplicated those in previously reported cases of radiation nephritis—thickened renal capsules, degenerative glomerular changes, tubular atrophy and interstitial fibrosis and endarteritis. The right kidney was more markedly affected than the left. It is thought that the more extensive capsular and parenchymal involvement on the right might be related to the extensive surgery and resultant fibrosis.

Other clinical features in this case deserve further comment. The telangiectases over the abdominal wall and back developed quite soon after radiation and were rather extensive. This finding aroused suspicion that gastrointestinal telangiectasis might have been a contributing cause of the protracted melena, and this was later confirmed at autopsy. Whether the protracted blood loss hastened the patient's renal failure or even caused deterioration in what otherwise might have been a relatively stable situation remains problematic. Meticcorten was employed in the hope of decreasing the degree of capillary bleeding. Although initially, clinical and hematological improvement coincided with its use, it would be difficult to establish a cause-and-effect relationship. Later in the patient's illness, the steroid seemed to have no appreciable effect, nor did it appear to contribute to the progressive renal insufficiency. The late development of leukopenia and thrombocytopenia remains unexplained.

Nephritis is an unusual complication of radiation therapy. There is some clinical evidence to suggest that renal insufficiency develops only when both renal areas have been irradiated with at least 2,500 r (depth) and when less than one-third of the total renal tissue is outside the critical radiation field (Kunkler *et al.*: Brit. J. Radiol. 25: 190, 1952. Abst. in Radiology 60: 326, 1953). The present authors believe that the natural history and prognosis of a given neoplasm, and the probable efficacy of radiation therapy, should be weighed against the danger of delivering bilateral renal radiation of potentially lethal degree.

One photograph; 2 photomicrographs; 1 chart.

Irradiation of the Entire Body and Marrow Transplantation: Some Observations and Comments. E. Donnell Thomas, Harry L. Lochte, Jr., and Joseph W. Ferrebee. Blood 14: 1-23, January 1959. (Mary Imogene Bassett Hospital, Cooperstown, N. Y.)

Much of this article is of primary interest to the hematologist. The radiologist, however, will get a great deal out of the discussion of the physical and biological problems involved in total-body irradiation and marrow replacement. He will also find the technical details of the delivery of uniform irradiation to a large volume most useful. Two opposed cobalt units with a 2-meter distance between each source and the midline of the patient lying in a centrally placed bed will afford a uniformity of effect that begins to approximate conditions known to be successful in mice.

Importance of uniformity of irradiation is stressed. It is pointed out that overtreating some areas and undertreating others is disastrous in a situation complicated by ubiquitous malignant cells. Optimal radiation would appear to be prolonged and of low rate, uniform, and generally calculated to extend over a period and area sufficient to catch each cell at its most radiosensitive and vulnerable time in the mitotic cycle.

After whole-body irradiation in the range of 300 to 700 r, death is primarily due to marrow failure. Experimental studies with marrow transplantation in an effort to repair the radiation damage are reviewed, and the problems involved in such treatment in man are discussed.

The authors point out that marrow function is more easily restored after irradiation than lymphoid function. Considerable evidence indicates that infusions of marrow do not restore satisfactory function in irradiated lymph nodes and spleens. Marrow is erythropoietic and myelopoietic but insufficiently lymphopoietic for these purposes, even when the difficulties of foreign marrow reaction are circumvented by adequate irradiation and the infusion of tolerant material.

The authors report 5 cases of acute leukemia in which treatment was by total-body irradiation followed by intravenous infusion of bone marrow. Of a series of several patients, of which these are a part, only 2 could be said to have received any significant clinical benefit.

Four figures; 1 table. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

Burn Following Accidental Exposure to High Energy Radiation. Lester M. Cramer, John H. Waite, John H. Edgecomb, Clinton C. Powell, John H. Tuohy, Eugene J. Van Scott, and Robert R. Smith. Ann. Surg. 149: 236-293, February 1959. (National Cancer Institute, Bethesda, Md.)

A unique aspect of this article is the histopathologic

sequence described following an accidental exposure to radiation energy from a Van de Graaff accelerator. Exact exposure dosage is not known but reconstruction of factors places the total electron dose at about 7,200 rep at the point of highest skin exposure. The peak energy of the electron beam was 0.6 Mev. The highest dose of penetrating x-radiation was estimated to be not over 100 r. Exposure time was approximately three seconds.

The case history presented follows the entire clinical course from the initial exposure to the 608th day and includes the pathological reports on excised tissue. No symptoms that could be identified as belonging to the acute radiation syndrome were seen, but none were anticipated, since the type of energy involved was almost wholly absorbed by 3 to 6 mm. of tissue.

The authors compare their staging of cutaneous response against that proposed by Robbins *et al.* (Radiology 46: 1, 1946) and Knowlton *et al.* (J.A.M.A. 141: 239, 1949. Abst. in Radiology 55: 475, 1950).

One color plate; 8 photomicrographs; 1 table.

JOHN C. POWERS, M.D.
St. Vincent's Hospital, New York

Reducing Gonad Irradiation in Pediatric Diagnosis.

Harry A. Bishop, Milo Webber, and Bernard J. O'Loughlin. California Med. 90: 20-25, January 1959. (University of California School of Medicine, Los Angeles 24, Calif.)

The greatest danger of carcinogenesis and of genetic damage through diagnostic radiological procedures is in children, whose small bodies are more vulnerable and who have a longer life span in which to realize this hazard. For their own determinations of exposure the authors used small sensitive dosimetry films. These were attached to the bodies of all children examined radiographically in a period of seven weeks—one to the skin where it would lie in the central beam, one on or near the scrotum or on the skin of the upper medial anterior thigh. The table shows gonad exposure, as reported in the literature, for various examinations.

Measures for reducing the dose to the skin and gonads are assembled from the literature. These include additional filtration, reduction of cone size, higher tube potentials, lead shielding, and the use of intensifying screens. Aside from technical factors the largest item in the overall reduction of exposure is the avoidance of unnecessary and undiagnostic studies. Fluoroscopy is the most dangerous of procedures and should be avoided when possible. Complete dark-adaptation of the eyes and the use of a small beam with the shortest possible exposure time will minimize danger from this source.

Two charts; 5 tables. SYDNEY F. THOMAS, M.D.
Palo Alto, Calif.

A Primer on Radiation Hazards for Physicians.

Richard E. Peterson, Julius G. Baron, Bartis M. Kent, and Titus C. Evans. Arch. Int. Med. 103: 308-328, February 1959. (University Hospitals, Iowa City, Iowa)

The citizen physician should be prepared to help maintain proper perspective in community discussions on radiation hazards. The material contained in the present *Primer on Radiation Hazards for Physicians* appeared as a Scientific Exhibit at the 43rd Annual Meeting of the Radiological Society of North America, Chicago, November 1957. It gives conclusions and opinions drawn from 107 references on the subject.

Four figures; 5 tables.

Half a Century of Progress in Radiodiagnostic Protection. J. A. Bloomfield. M. J. Australia 1: 289-292, Feb. 28, 1959.

The author reviews data published by others relative to the hazards and possible delayed untoward effects resulting from medical uses of ionizing radiation. He attempts by means of these data to place a proper perspective on the apparently small risk in contrast to the great medical gains to be realized from judicious use of diagnostic and therapeutic applications of radiation. The communication contains general information helpful

GNAD AREA EXPOSURE DOSES IN DIAGNOSTIC RADIOGRAPHY OF CHILDREN (IN MILLIROENTGENS)
(BISHOP, WEBBER, AND O'LOUGHLIN)

	0-2 Yr.		Age Group 2-7 Yr.		7-11 Yr.	
	Male	Female	Male	Female	Male	Female
Chest, postero-anterior	0	2	0	0	0	0
Chest, postero-anterior	5	...	...	...	...	...
Chest, postero-anterior	...	...	0.2	0.06	3.3	3.3
Chest, lateral	...	...	0.5	6.0	0.15	6.0
Skull, basal	1	1	0	0	0	0
Skull, lateral	...	...	0.01	0.025	0.006	0.02
Skull series	...	...	...	...	0.4	0.25
Abdomen, anteroposterior	150	...	310	130	250	240
Abdomen, anteroposterior	...	...	82	46	240	95
Lumbar spine, lateral	800	300	500	1,200	300	730
Lumbar spine, lateral	...	...	190	110	145	180
Lumbar spine series	...	...	270	160	300	250
Pelvis, anteroposterior	160	90	280	140	700	300
Pelvis, anteroposterior	...	...	90	50	120	50
Hip, anteroposterior and lateral	...	...	180	100	570	200
IVP	500	300	1,008	678	1,520	1,384
IVP	...	...	330	180	1,000	370
IVP	...	...	...	...	654	706
Gastrointestinal series	220	...	496	...	220	...
Gastrointestinal series	...	...	32	96	50	185
Barium enema	450	400	700	455	900	800
Barium enema	...	...	36	96	64	220

to those desiring background information in the field of radiation hazards.

Four tables.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

Acquired Radioresistance. A Review of the Literature and Report of a Confirmatory Experiment. Michael P. Dacquist. *Radiation Res.* 10: 118-129, February 1959. (Walter Reed Army Institute of Research, Washington, D. C.)

The development of significant radioresistance as a result of exposure to small doses of x-irradiation seems to be well established experimentally. The author describes an attempt to delineate some time and exposure relationships of this acquired radioresistance.

For control adult female white Swiss mice, Walter Reed strain, the LD 50/30 was found to be 487 ± 25.7 r. This increased to 560 ± 31.0 r if the mice were given 50 r whole-body irradiation, ten days earlier, and to 617 ± 32.0 r if the interval was extended to seventeen days. In this experiment radioresistance was manifest at both ten and seventeen days after the small exposure.

Analysis of spleen and thymus weights under the conditions of the present experiments gave no clue to the mechanism of the acquired radioresistance. Alternate hypotheses are discussed, but the phenomenon remains unexplained.

Five graphs; 2 tables.

Rate of Recovery from Radiation Damage and Its Possible Relationship to Life Shortening in Mice.

John B. Storer. *Radiation Res.* 10: 180-196, February 1959. (Roscoe B. Jackson Memorial Hospital, Bar Harbor, Me.)

Blair (University of Rochester Reports UR-206 and UR-207, 1952), utilizing the concept of a constant repair rate for reparable radiation damage and the premise that a portion of the damage does not repair, has advanced an interesting hypothesis that attempts to relate the acute LD 50 to mean survival time (life shortening) at long intervals after radiation exposures. Since various reports are available on the survival times of mice exposed to a variety of daily doses of radiation, it was considered worthwhile to re-examine these data and to calculate mean recovery rate constants for animals exposed to different numbers of daily doses. If a systematic variation in recovery rate with a number of fractions could be demonstrated, it was then planned to modify certain aspects of Blair's hypothesis accordingly and to apply the modified hypothesis to certain cases of experimentally produced life shortening from radiation. These calculations and modifications of the Blair hypothesis are the subject of the present report.

The author found that the mean rate at which mice recover from the radiation damage contributing to acute death can be related empirically to the number of daily radiation doses delivered. Recovery from neutron-induced damage is slower at all intervals than from that caused by x- or γ -radiation. By using the empirically derived relationships and certain assumptions about the change in LD 50 with age, it was possible to predict the general form of the relation between daily dose and shortening of life span. The application of the equations obtained to the problem of increased sensitivity to further exposure after various regimens of small daily doses is discussed. A hypothesis relating recovery rate to life shortening in general is advanced.

Five graphs; 6 tables.

Short and Long-Term Observations Concerning the Effect of Homologous and Heterologous Cell-Free Spleen Extracts on Radiation Mortality in Mice and Guinea Pigs. F. Ellinger. *Atompraxis* 4: 439-444, December 1958. (Naval Medical Research Institute, Bethesda, Md.)

Previous and current investigations indicate that cell-free saline whole extracts from the spleens of mice and guinea-pigs contain a humoral factor which protects the same or a different animal species against irradiation death. The cell-free crude spleen extracts used in these experiments not only protect against the immediate lethal action of ionizing radiation but remain effective for a period of many months. Cell-free organ extracts avoid, therefore, one of the main difficulties encountered in the utilization of organ preparations containing viable cells, namely, the immunobiological rejection reaction against the implant, manifested in weight loss and delayed deaths some months after irradiation when recuperation of the reticuloendothelial system from the impact of irradiation occurs. They offer, furthermore, the additional advantage of easy storage over many months.

The author's preliminary physicochemical studies seem to point to a method of separating the protective factor of spleen extracts from simultaneously present chemical components of inert or even toxic nature. It appears, therefore, that the previously expressed "hope" of obtaining an effective nontoxic, universally applicable countermeasure against radiation-induced mortality, to be employed in the postirradiation period, can now be achieved, but this obviously will not be easy.

Six graphs.

The Response of Eosinophils to Total-Body X-Radiation of the Monkey. Earl Eldred. *Blood* 14: 187-193, February 1959. (University of California School of Medicine, Los Angeles 24, Calif.)

The response of eosinophils in the peripheral blood of the *Rhesus* monkey to total body-x-radiation in the median lethal range was studied. Each of a series of 23 presumably normal animals was given a single dose of 550 or 600 r (conventional x-ray qualities). Eosinophil counts were made at frequent intervals with special counting procedures utilizing the phloxine-propylene glycol technic. For each animal a pre-exposure eosinophil base line had been determined.

Typically the eosinophil levels fell to about one-half their pretreatment value during the first three days. By the fourth and fifth days eosinophils were seriously depleted and for many days thereafter were scarce. In those monkeys which survived, a "wave of eosinophilia" appeared between the thirtieth and the fortieth day, at which time counts reached as high as 16,300 cells per cubic mm. (average normal level around 500 per cubic mm.). The eosinophil count tended to remain at high levels over ninety days following exposure. Maximal eosinophilia occurred in the fifth to seventh weeks.

The author presents data published by others showing similar findings for monkeys and for other animals subjected to similar experiments. He also notes that relative eosinophilia following clinical irradiation has been known for some time.

Typical curves showing circulating eosinophil levels are reproduced.

Two graphs.

JAMES W. BARBER, M.D.
Cheyenne, Wyo.

The Effect of X-Irradiation on the Antioxidant Activity of Mammalian Tissues. Albert A. Barber and Karl M. Wilbur. *Radiation Res.* 10: 167-175, February 1959. (A. A. B., Department of Zoology, University of California, Los Angeles 24, Calif.)

Two lines of investigation have indicated that oxidation reactions are of significance during the initial phases of radiation damage. The first concerns radical production in aqueous media exposed to ionizing radiation, and the second chemical protection both *in vitro* and *in vivo*. The studies on chemical protection have indicated that one of the mechanisms might involve the inhibition of the oxidation reactions due to free radical activity, and many of the protective agents such as reducing agents and chelating agents do have antioxidant properties.

The absence of lipid peroxides in normal animal tissue suggests that some antioxidant mechanism prevents their formation; their presence in irradiated tissues has been explained by the destruction of this normal antioxidant activity by radiation. To determine whether this is the case, studies were made of tissues from normal and irradiated animals.

Tissue antioxidant activity was measured by the capacity of tissue supernatants to inhibit peroxide formation when added to rat liver homogenate. Blood, ascitic fluid, intestinal mucosa, and bone marrow had the highest antioxidant activity. Testis and spleen had less, and liver and brain had none. Peroxide formation in this test system was inhibited by citrate and EDTA. FeCl_3 and low concentrations of ascorbic acid were catalytic.

Whole-body x-irradiation (800 r) destroyed the antioxidant activity of the mucosa but had no effect on that of other tissues. The mucosa from irradiated animals catalyzed peroxide formation in incubated methyl linolenate emulsions as well as in the liver homogenate. When tested by the inhibition of melanin formation, the antioxidant activity of irradiated mucosa was some-

what less than that of the unirradiated controls, but it never catalyzed this reaction.

Three graphs; 3 tables.

The Effect of Single and Multiple Doses of Co^{60} Gamma-Radiation and Fission Neutron Radiation on the Incorporation of Fe^{59} into the Rat Erythropoietic System. W. A. Rambach, J. A. D. Cooper, H. L. Alt, H. H. Vogel, Jr., J. W. Clark, and D. L. Jordan. *Radiation Res.* 10: 148-166, February 1959. (W. A. R., 303 E. Chicago Ave., Chicago 11, Ill.)

The investigation described here was concerned with the effect of both single and multiple doses of Co^{60} γ -rays and fission neutrons on the distribution of Fe^{59} in rat plasma, bone marrow, red blood cells, liver, and spleen.

The irradiation caused a decreased incorporation of radioiron into the bone marrow and spleen, with a consequent decrease in the level of Fe^{59} in the peripheral red cells and an increase in the levels in plasma and liver iron. The mechanism of this redistribution is discussed.

From the data on acute exposure, with the incorporation of Fe^{59} into bone marrow as a biologic endpoint, an approximate relative biological effect of 1.0, fission neutrons to Co^{60} γ -rays, is derived.

Repeated exposure to doses of neutron or γ -irradiation below 32 rads produced little or no immediate irreparable damage to the hematopoietic system. With both acute and chronic exposure there was a great propensity for recovery of the erythrocyte system. Higher doses of repetitive exposure, 81 rads and 150 rads, are, however, capable of producing change from which recovery is obviously slower. It is possible that some residual effect of radiation, at present not measurable, may exist which in the future will reveal itself in hematopoietic aberration.

Two photographs; 3 graphs; 5 tables.



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